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VOL. XXXX, No. 1, 1957

THE

MALAYAN AGRICULTURAL JOURNAL

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MINISTRY OF AGRICULTURE, FEDERATION OF MALAYA,
Kuala Lumpur.
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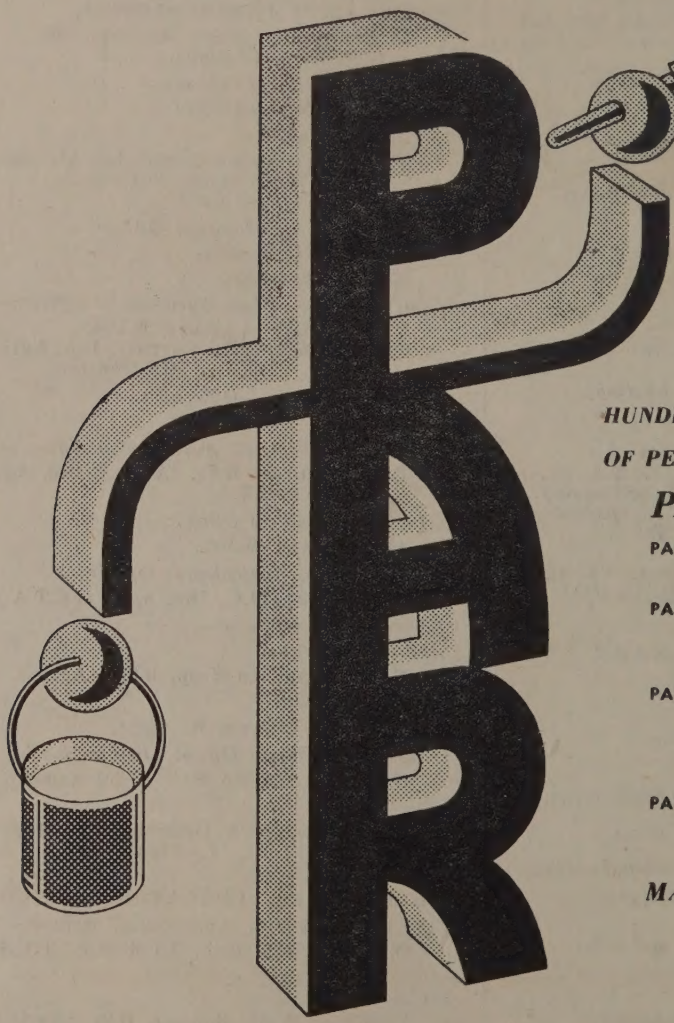

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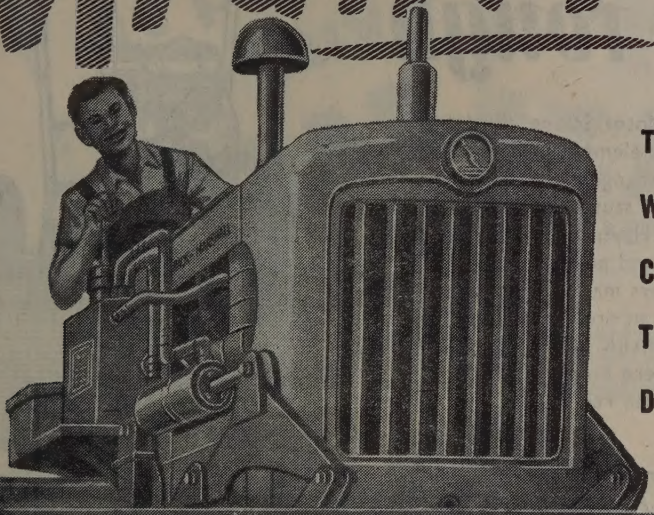

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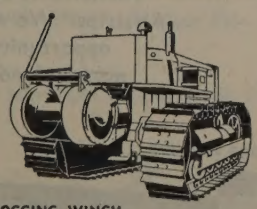

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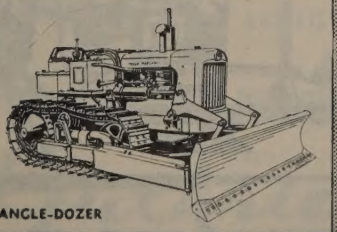

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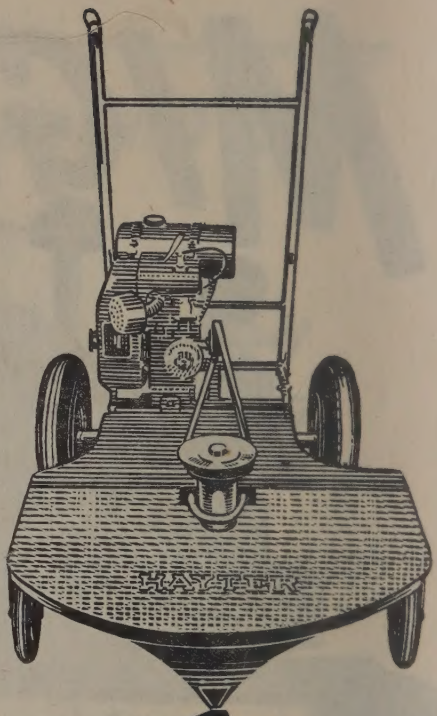

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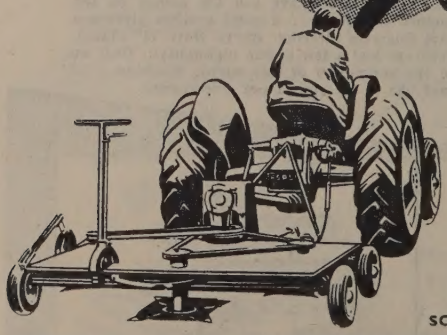

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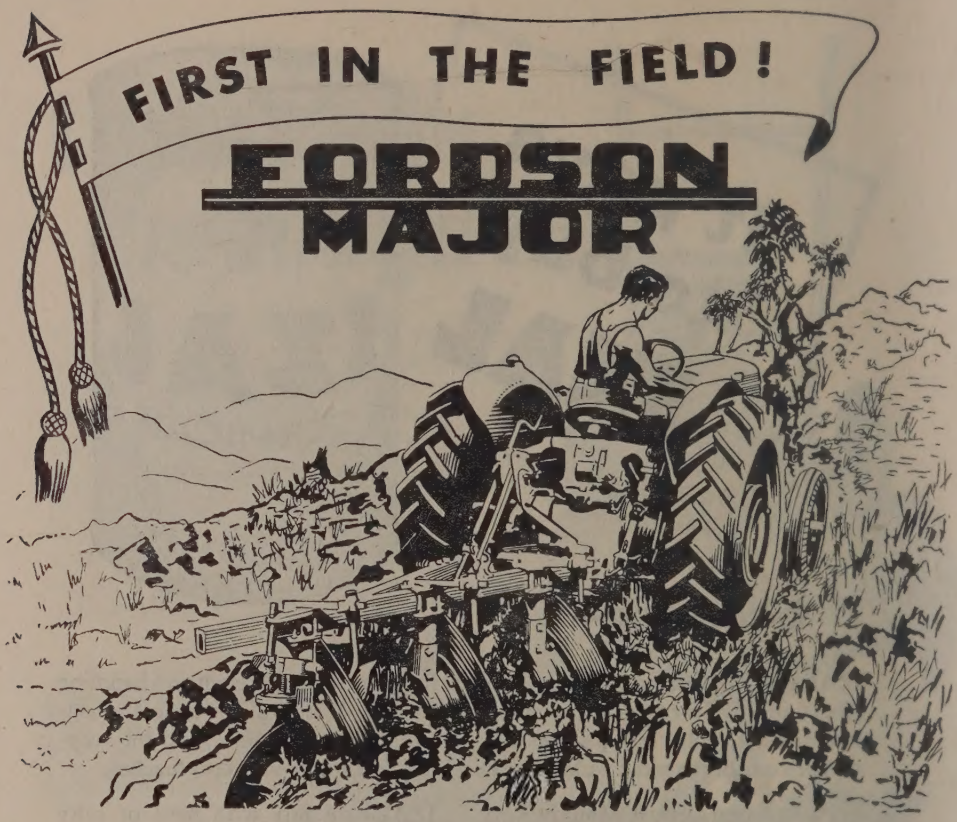

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THE

Malayan Agricultural Journal

Edited by the Publications Officer with the Assistance of
The Publications Committee

Vol. XXXX No. 1, 1957

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THE MALAYAN AGRICULTURAL JOURNAL

The Journal is designed to present—as far as possible in non-technical terms—the results of the agricultural research, investigation and extension work in Malaya performed by the Department of Agriculture. Also, by means of selected articles, abstracts and reviews, this publication draws attention to the results of work of a similar nature in other countries, which have a bearing on agriculture in Malaya.

The Department of Agriculture does not necessarily recommend the use of any product advertised in the Journal by commercial firms.

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THE
Malayan Agricultural Journal
Vol. 40, No. 1, 1957

EDITORIAL

Heart Rot of Pineapple. Heart rot disease of pineapple, which is now known to occur in all the main pineapple-growing areas of Malaya, is described in this issue of the Journal and measures for its control are suggested.

It is thought that the bacterium causing the disease is a specialised strain of *Erwinia carotovora*, which is also known to cause the disease known in Malaya as fruit collapse.

Most outbreaks of heart rot disease have occurred on peat soil and have been of a minor and sporadic nature. However, a more severe attack has taken place recently on a hilly area of soil based on quartzite. This recent attack, plus the fact that undestroyed plants suffering from heart rot disease may act as carriers of fruit collapse infection, have caused greater attention to be paid to what was at one time considered to be a minor disease.

Helping the Farmer. The second article in this issue of the Journal describes how the Department of Agriculture in Selangor is tackling the problem of improving smallholders' agriculture in the State. In particular the article describes the progress made in the Kuala Langat District.

Soil Survey Reports. Another soil survey report appears in this issue. This time it is the report of a soil survey carried out at the Federal Department's experiment station at Jerangau, Trengganu.

Jerangau was chosen as the site for this station because it is representative of one of Malaya's main soil groups and climatic zones. It is thought that much land in the vicinity of the Station is suitable for the cultivation of cacao and, indeed, Malaya's first commercial plantings of this crop have been undertaken nearby.

The majority of the experiments and investigations being conducted at the Federal Experiment Station, Jerangau, involve cacao, but some work is being carried out on oil palms.

Growing Wet Padi on Peat. The fourth article in this number of the Journal summarises the results of attempts to grow wet padi on peat soils in Perak and Trengganu.

It is estimated that there are over 1,000,000 acres of peat soils in Malaya, and attempts prior to 1951 to grow wet padi on such soils always failed. The experiments described here give promise of reasonable yields from wet padi growing on peat when there has been surface burning of the peat followed by applications of phosphate. The experiments provided no evidence to show that minor elements are of benefit to wet padi growing on peat soils.

BACTERIAL HEART ROT OF THE PINEAPPLE

BY

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Introduction

The term 'heart rot' in the pineapple plant is used to describe a disease causing the growing point and the basal parts of the central leaves of young plants to be affected by a rot and to die. Fungous diseases of this type, caused by species of *Phytophthora*, have been reported from several parts of the world including Assam, Hawaii, Queensland and Mexico. In Malaya a disease with similar symptoms may have been observed by officers of the Department of Agriculture as early as 1927, as a "pineapple bud-rot, associated with bacteria" is mentioned in the Annual Report of the Division of Mycology for that year (4). The first definite record of the disease does not appear, however, until 1936, when heart rot was reported from Johore (5). Investigations to discover the cause of the disease were begun in that year and continued until 1940 (6, 7) but no pathogenic organism was found and the cause of the disease was not elucidated. Influenced by the fact that similar diseases in other countries were caused by species of *Phytophthora*, early work was largely concentrated on a search for and attempts to isolate such fungi from Malayan specimens, and this no doubt explains the early failures to discover the causal organism.

Heart rot investigations were recommenced in 1952, when a bacterium capable of reproducing the disease was isolated from an affected plant (1). Further work on the subject had to be postponed and more detailed investigations were not resumed until 1955.

Occurrence

All pre-war reports of heart rot came from Johore (6) and in the post-war period, up to the second half of 1955, the disease had only been observed in the Pontian district of that State. In September, 1955, it was found for the first time outside Johore, in the Sekinchang area of Selangor, and in November, 1955, in the vicinity of Ayer Hitam, Johore. In May, 1956, its presence in the south of Perak was confirmed and in June it was found at the Federal Experiment Station, Jalan Kebun, Selangor. The disease has thus now been found in all the main pineapple-growing areas of the country.

Economic Importance

The disease as found in the peat areas of Pontian (at present the most important pineapple-growing area in Malaya) affects only a small proportion of plants. Several contiguous plants may be affected but often only one or two scattered cases occur and the damage done is of little economic importance. Recently a more serious attack has developed on hilly areas of soil

developed on quartzite in the Ayer Hitam district, where it is estimated that about 10 per cent of the plants in some areas have been lost. As in Pontian, the incidence of the disease in Selangor and Perak (where the soil is also peat) has so far been low.

Varietal Susceptibility

No information is available on the comparative susceptibility of different varieties in the field, as commercial plantings are almost entirely confined to the single variety Singapore Spanish, Laboratory tests indicate that the varieties Singapore Spanish, Sarawak, Selangor Green and Mauritius are equally susceptible, typical heart rot symptoms having been produced in all these varieties by artificial infection.

Symptoms

In typical cases of heart rot disease, infection usually takes place in young plants between the ages of about three and eight months. The first sign of disease is that the basal parts of the youngest leaves assume a dull, water-soaked appearance, becoming darker green than the healthy tissues (Plate I). The colour changes to a dull greenish-yellow as infection spreads rapidly upwards through the internal tissues of the leaves. The whole leaf may be affected (Plate II, A) or the upward spread of the disease may be arrested part way up the leaf (Plate II, B). In the latter case, the upper edge of the infected area is bounded by one, or sometimes more, dark purple or brown bands. Above this there may be a broader, lighter-coloured area separated from the healthy part of the leaf by an indefinite yellowish zone (Plate III).

The basal parts of infected leaves become so completely soft-rotted that the central rosette of leaves can easily be lifted out of the heart of the plant. Further up the leaf the internal tissues disintegrate completely but the epidermis remains intact. In a few cases the rotted parts of the leaves have been found to be distended with gas, but this appears to be unusual.

Although typically this is a disease affecting young plants, similar symptoms are also sometimes found on older plants, even when these are bearing fruit. Then the bases of the leaves are rotted as in young plants and in addition the rot extends up into the stem of the fruit.

Longitudinal section of an infected plant shows that infection also spreads downwards, when the growing point is affected by a soft rot which entirely destroys it (Plate V). The infected tissues disintegrate into a soft mass of buttery consistency, grey-green or fawn in colour. The rotted part is sharply separated from the surrounding healthy tissue by a narrow purplish or brown zone. A section of this type clearly shows that infection takes place in the heart of the plant and from there spreads outwards.

Diseased tissues have a strong putrid odour.

The disease progresses rapidly and, because of this, early stages are rarely found in the field. Usually, by the time an affected plant is observed, a large number of leaves have become infected and the growing point has already been killed. A plant showing typical symptoms of an advanced stage of the disease is illustrated in Plate IV.

In severe cases, the plant may be completely killed by the disease but an infected plant usually continues growth by producing new shoots from lateral buds. As infection is normally confined to the heart of the original shoot, these lateral buds do not become diseased except by chance reinfection.

The Causal Organism

Isolation

Examination of tissues affected by heart rot showed that numerous bacteria were present in the diseased areas, and the presence of the bacteria close to the advancing edge of the lesion suggested that they might be the cause of the disease. Isolations were made by surface-sterilising an affected leaf, teasing out a small piece from the edge of the rotted area in sterile distilled water and plating out on nutrient agar. From these plates pure cultures of several different species of bacteria were obtained.

The pathogenicity of these isolates was tested by inoculating them into healthy plants. These laboratory inoculations were carried out by pouring a suspension of the bacteria into the hearts of young plants growing in pots. The heart tissues were pricked through the bacterial suspension with a sterile needle to facilitate infection, after which the heart was plugged with wet, sterile cotton wool covered with a small square of polythene sheeting to maintain high humidity at the point of inoculation.

In the first tests, carried out in 1952, one bacterial isolate was obtained which was capable of reproducing the disease. In subsequent investigations in 1955-56, isolations were made and pathogenicity tests carried out in the same way and further cultures of bacteria capable of producing heart rot were obtained. Nine pathogenic isolates (three from Selangor, one from Perak, one from the Ayer Hitam district of Johore and four from the Pontian district of the same State) were examined and were found to be morphologically and physiologically identical.

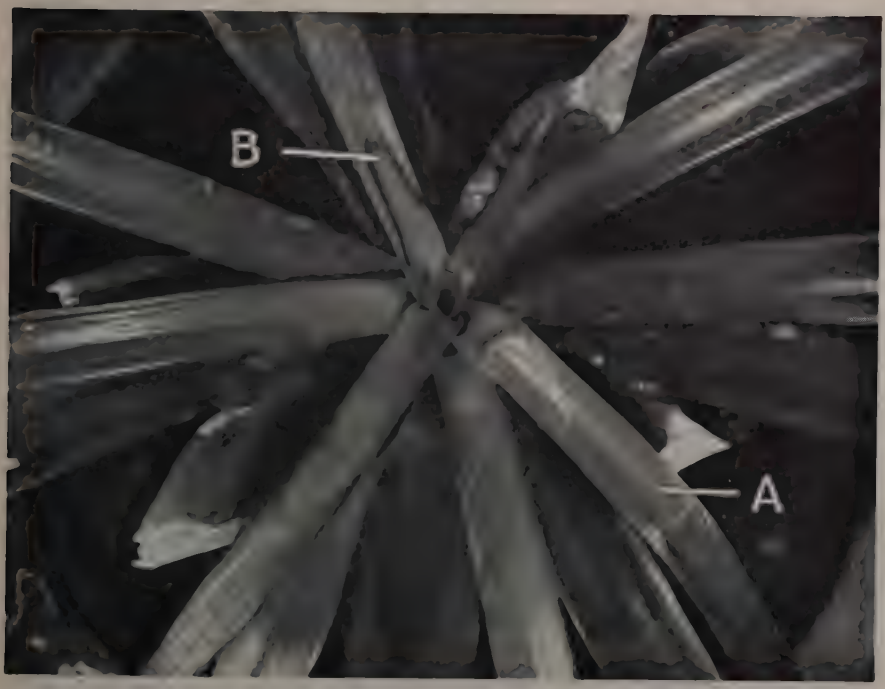
Proof of Pathogenicity

Proof of the pathogenicity of the bacteria isolated from plants affected by heart rot was obtained from numerous inoculation experiments. For example, in one experiment 16 plants were artificially infected in the same manner as described above with an isolate from Johore. Four control plants were treated in the same way except that sterile distilled water was used in place of the bacterial suspension. Typical symptoms of heart rot began to develop in all the inoculated plants within four days of inoculation, whereas all the control plants remained healthy throughout the experiment. The bacterium was reisolated from the advancing edge of the rotted parts of inoculated plants. Similarly, in another experiment in which 16 plants were inoculated and eight uninoculated plants were kept as controls, all 16 inoculated plants developed heart rot within a week of inoculation while all the controls remained healthy. Altogether, 93 plants have been inoculated with different bacterial isolates; 81 of these inoculations were successful.

PLATE I

Very early stage of the disease.

PLATE II



Later stage of the disease, showing (A) leaf completely rotted along its whole length and (B) leaf in which the upward spread of the rot has been arrested.

PLATE III

Leaf from a diseased plant showing, from the left, the rotted basal part, a narrow dark band followed by a lighter band and the indefinite yellow zone merging with the normal green tip.

PLATE IV

Advanced stage of the disease.

PLATE V

Longitudinal section of a diseased plant. Growing point completely destroyed.

PLATE VI

The bacteria causing heart rot, magnified approximately 1,750 times.

Of the 12 that were unsuccessful, 11 occurred on plants in which the tissues had not been injured by pricking, indicating that damage to the heart of the plant is necessary for infection to occur. Of the 45 control plants used in these experiments, not one developed the disease.

In artificially induced infections the first disease symptoms occur within 18 hours of inoculation, by which time the basal parts of the central leaves show a dull green, water-soaked appearance. After two days the rot extends for several inches up the leaves, of which five or six are usually affected, the symptoms then being typical of the earliest stage of the disease found in the field. Under dry conditions such as occur in the laboratory, the disease does not progress far beyond this stage, except for a slower extension of the rot up the infected leaves; the growing point is not affected. However, under wet conditions (e.g. if the inoculated plants are put out in the open during wet weather) more extensive rotting and collapse of the leaves takes place, the rot extending downwards and killing the growing point.

Morphological and Physiological Characters

The description of the bacterium which follows is based on an examination of six isolates, three from Selangor, two from Johore and one from Perak. The physiological tests were carried out largely as described by Dowson (2).

The pathogen is a Gram-negative, non-sporing, highly motile rod, occurring singly or occasionally in pairs. The 48-hour cultures on beef-extract-peptone agar consist of short, straight rods with rounded ends, 1.2 - 3.5 x 0.5 - 0.8u (mean 2.2 x 0.6u) (Plate VI).

On beef-extract-peptone agar plates, colonies are up to 2 m.m. in diameter, raised, roughly circular with sharp somewhat angular margins, smooth or radiately ridged, glistening. Their colour is greyish-white by reflected light, golden-yellow by transmitted light. On slants of the same medium, growth is thin, filiform, glistening, greyish-white. The medium is not discoloured.

Beef-extract-peptone broth clouds rapidly with the formation of an imperfect pellicle. The addition of two per cent glycerine to the broth results in considerably more rapid and vigorous growth and the formation of a thick, complete, tough pellicle.

On steamed potato cylinders, the growth is slightly raised, smooth and glistening and is creamy-yellow in colour. The potato cylinder is not digested.

In nutrient gelatin stabs, liquefaction takes place rapidly, the region of liquefaction being at first crateriform, later becoming infundibuliform. Ultimately all the medium becomes liquefied.

Nitrate is reduced to nitrite, indol is produced from tryptophane and ammonia is produced from peptone. There is slight production of hydrogen sulphide in peptone water by some but not all isolates. The Voges-Proskauer test gives a positive reaction, the methyl red test a negative reaction.

Growth in synthetic basal medium with the following compounds produces both acid and gas:— arabinose, dextrose, galactose, lactose, laevulose,

maltose, mannose, raffinose, rhamnose, sucrose, xylose, mannitol, sorbitol, aesculin and salicin. Some isolates produce acid but no gas in arabinose, lactose, maltose, raffinose, rhamnose, sucrose, xylose and aesculin. Acid but no gas is consistently produced in synthetic media containing glycerol, dextrin and inulin. Neither acid nor gas is produced in media containing starch and dulcitol.

Coagulation takes place in litmus milk, the upper half of the milk becoming clear. The litmus turns pink at first but ultimately becomes reduced and colourless.

Pectate-gel medium is rapidly liquefied, as are raw slices of carrot, radish, onion and cucumber.

On plates of meat-extract-peptone agar with starch added, the starch is hydrolysed.

IDENTITY

The characteristics outlined above, and particularly the diagnostic character of acid and gas production from salicin in a peptone-free medium, indicate that the bacterium is a member of the genus *Erwinia*.

The nature of the damage which the bacterium causes and the fact that it is able to liquefy a pectate-gel medium and cause rapid rotting and liquefaction of slices of carrot, radish, onion and cucumber show that it is a typical soft-rotting organism. Its morphological and physiological characters accord well with those of the widespread and common soft-rot organism *Erwinia carotovora* (Jones) Holland as described, for instance, by Elliott (3) and Dowson (2). The organism is therefore regarded as a strain of that variable species.

Erwinia carotovora has already been recorded in Malaya attacking several crops, including species of *Brassica*, lobak (*Raphanus sativus* var. *hortensis*) and carrot. To discover whether strains from other hosts could attack pineapple, isolations were made from pak choy (*Brassica chinensis*) and lobak. These isolations were inoculated into healthy young pineapple plants but heart rot did not develop. Many more tests would be required before a definite statement could be made, but from the small number of tests so far made it would appear that the bacterium causing pineapple heart rot is a specialised strain of *E. carotovora* and that the commonly occurring strains cannot attack pineapple. That bacterial heart rot has not occurred in other pineapple-growing countries where *E. carotovora* commonly occurs, supports this belief.

Control

The incidence of the disease has up to the present usually been sporadic, so that direct control by prophylactic spraying with a fungicide would in most cases be uneconomical. To discover whether such spraying would give control of the disease, however, an experiment was laid down in Johore in an area where heart rot had been widespread in the previous season. Treatments used were spraying, at intervals of 10 days, with Bordeaux mixture (4:5:40) and with streptomycin sulphate (0.01 per cent solution in water). Unsprayed plots were also included for comparison. Spraying was begun

two months after planting and continued for nine months. The experiment was then concluded as the plants had by then passed the most susceptible age. The number of plants affected by heart rot in each treatment is shown in Table I.

Table I

Pineapple Heart Rot Spraying Experiment

Treatment	Mean Number of Plants Affected by Heart Rot per Plot
Bordeaux mixture	2.5
Streptomycin sulphate	7.6
No spray	9.3

Standard Error = 4.2
Minimum Significant Difference (5 per cent) = 9.3
Layout: × 6 randomised block

Each plot at the beginning of the experiment contained 200 plants; the overall incidence of heart rot can therefore be seen to have been low (mean 3.3 per cent). Although considerably fewer diseased plants occurred in the plots sprayed with Bordeaux mixture than in the other plots, the difference was not significant.

As regular fungicidal spraying must at present be ruled out because of expense and ineffectiveness, other control measures must be sought. The measures suggested below are aimed at reducing the chances of infection by simple field practices which can be easily and cheaply carried out:

(i) Slips should be treated before planting by dipping them in Bordeaux mixture to reduce the danger of early infection. [This is normally done in many areas to guard against green die-back, caused by copper deficiency.]

(ii) Care should be taken when planting and subsequently to prevent the entry into the heart of the plant of possibly contaminated soil.

(iii) Badly affected plants which are likely to be completely killed by the disease should be dug up and destroyed by burning or deep burying.

(iv) Slightly affected plants in which the rot does not extend to the outer leaves often recover by producing lateral shoots. To aid recovery of these plants and to prevent their acting as centres of infection, the central rotted leaves should be pulled out and destroyed and the heart should be sprayed with Bordeaux mixture or some other copper fungicide.

Summary

Pineapple heart rot disease is described and shown to be caused by a bacterium, identified as a strain of *Erwinia carotovora* (Jones) Holland.

A field experiment showed that spraying with Bordeaux mixture or streptomycin sulphate did not give control of the disease; alternative control measures are suggested.

Acknowledgements

Thanks are due to Dr. W. J. Dowson, of Cambridge University, who first suggested that the bacterium involved in heart rot might be *E. carotovora*, and to Mr. G. F. Darnell, Agricultural Officer, Johore Central, and his staff for carrying out the field spraying experiment.

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AGRICULTURAL EXTENSION IN THE KUALA LANGAT DISTRICT, SELANGOR

BY

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Introduction

It is not easy to define exactly what is meant by the term Agricultural Extension. Extension is the channel through which advanced and proven ideas are passed on to farmers. It is the link between the purely technical services of the Department of Agriculture and the farmer.

Sometimes the improvements which the Department desires to introduce through extension are of such a kind that it is easy to devise means of effecting the improvements and also to obtain a measure of progress and thus of the efficacy of the means employed. So, for example, where the effectiveness of a certain fertiliser dressing applied to padi has been proved, it is comparatively easy to advertise the improved practice by the use of demonstration plots and suitable large scale propaganda. Progress is easily assessed in bulk of fertiliser sold. Similarly, it may be desired to introduce improved planting material, which might be a padi variety or budded fruit. The measures needed to encourage planters to take up this type of improvement are easily devised and progress can again be assessed quantitatively. In suitable cases progress with this type of extension enterprise can be stimulated by means of subsidies or, in other cases, e.g. the obligation to plant only approved rubber planting material, by legal sanction.

Intensive programmes of the type instanced above do not however cover all the needs of the farming community, and what officers of the Department of Agriculture really try to do is to bring about a general improvement in farming standards and thereby an improvement in the economic status of the farmer. In the present stage of development of smallholding agriculture in Malaya, most of the ideas which the extension worker tries to propagate in order to bring about improvement are comparatively simple and straightforward. It is often easy to see where improvement is required but it is by no means easy to effect such improvement in practice. The aim is a general improvement in agricultural practice, but such an aim can be somewhat vague; the sum of the improvement desired is made up of a multitude of small things. It is necessary, if results are to be achieved, to direct the effort of extension workers according to a well defined programme; it is also desirable to be able to obtain a measure of the effectiveness of such a programme. This is by no means easy when the extension effort is directed, as it must be, to bringing about a "general improvement" in standards. It was from the desire to give extension workers a definite aim, and to have a means of assessing results, that the system of concentrating effort on a limited number of "progressive farmers" was developed in Selangor.

When the system was introduced, it was largely experimental. The staff of the Department in Selangor were not sure exactly what was wanted nor how much could be achieved, and for the first year, although it has been applied to varying degrees in all districts, a particular effort was made to follow progress and development in the Kuala Langat District. This area was selected because the Agricultural Assistant in charge was experienced and established in his District, because the farming population were judged to be responsive and perhaps more energetic than the average, and because any extension programme to be followed must of necessity be fairly general in its scope. There is no significant padi area in the District and the agriculture is fairly diverse.

Description of the District

Kuala Langat District is an area of some 385 square miles and large parts of it are under swamp forest. The soils of the area are mainly coastal alluvium varying from silty loam to heavy clay overlain in parts with a varying depth of peat. Except for peat jungle there is little available uncultivated land; indeed the pressure of population in some localities is severe. Values of developed land are very high. Cash crops grown in the District are coconuts, Liberian coffee, rubber, pineapples and mixed fruit. There is considerable production of vegetables, which is centred in the new villages. Population at the time of the 1947 census was estimated to be 68,427, made up of 26,156 Chinese, 24,677 Malays, 17,269 Indians and 325 others. The Malays are chiefly of Indonesian origin. The Chinese are now largely concentrated at Jenjarom, Tanjong Sepat, Sepang, Sungei Pelek and in the towns. There are aboriginal reserves at Bukit Bangkong and Bukit Changgang.

The Departmental organisation in the District consists of one Agricultural Assistant and two Junior Agricultural Assistants working out from small demonstration stations at Telok Datoh and Jenjarom. Staff numbers are severely restricted, bearing in mind the large farming population and wide extent of the District, and it is thus vitally necessary that their work must be most carefully planned if all effort is not to be lost.

The Department's staff in the District cannot concentrate solely on agricultural extension. There are other demands on the time of the Agricultural Assistant such as land inspections, District committees of various kinds, the compilation of statistical returns, general advisory work, and the administration and supervision of the Agricultural Stations. These activities cannot be avoided and make very considerable demands upon his time. What is left over is available for extension proper.

The Extension Programme

As explained, in planning an extension programme it was desired to find a means of giving the Agricultural Assistant engaged in somewhat general extension activities a definite programme of work. It was decided that one way of achieving this object would be to compile a register of

farmers with whom the Department made contact and upon whom he would concentrate his efforts. There were many objects in making up the register and it will be convenient to list the main ones below:-

(a) Continuity. During his period of working in a district the extension worker makes contact with a number of farmers. When he hands over to another, particularly where little time is allowed for the hand over, these individual contacts may be lost and his successor has to start all over again. The new man taking over a register has his contacts ready made.

(b) "After Sales Service". A man who has made contact with the Department, either as a result of enquiry or by purchase of planting material, should expect continued attention and to receive advice on how best to utilise his purchase or the knowledge he has gained.

(c) Information. Unless some system is available of recording the results achieved from advice given, or improved material distributed, the effectiveness of the extension worker's effort cannot be measured.

(d) Supervision. Given only a rather general programme to follow, the extension worker, with the best will in the world, can waste his efforts through lack of planning while the worker who has not got his heart in the job can bluff his way through years of service moving in a leisurely manner from one coffee shop to another.

It was unlikely that, with the limited staff available, it would be possible to cover fully all the objects listed above, and it was decided at the outset that priority should be given to the aspects which most closely concerned the farmer himself. That is to say the "after sales service" aspect was considered to be of greater importance than the collecting of information. It is more important to achieve real results in a few cases than to amass interesting data about projects which have failed for one reason or another. If a man is to be given special attention he should be made to feel that he can expect a visit from the extension worker at regular intervals once a month, or at least once in two months. Obviously the number of people who can be given this sort of attention must be severely limited. Nevertheless it was decided in the first instance to register as many "contacts" as possible, to follow as many of them as was practicable and, if necessary later, to restrict the number.

Since the system was bound in the first instance to be experimental, it was essential to keep it simple and flexible. Various refined methods such as clip card systems were considered but, as it was clear from the outset that the Agricultural Assistant would only be able to handle a limited number of contacts and give them regular attention, it was realised that there would be no difficulty in sorting and classifying the registrations. It was decided therefore to use a plain card index. The face of the card shows the farmer's name, address, soil type, particular interests and lists any purchases of planting material, etc. from the Department. The back of the card is a diary of visits made by extension staff with notes of progress made. Copies of sample cards are shown in the appendix. Instructions were given to

register, in the first place, every contact made. These contacts might arise from enquiries received, by sale of planting material or livestock or they might be farmers with whom the Department was not previously in touch but who were selected for their progressive attitude.

It very soon became obvious that, however desirable it might seem, it would not be possible to follow up each contact in detail. New contacts were then only registered if it was quite evident that they intended to operate on a considerable scale or that they were otherwise sincere in their intentions. Thus a man who bought two or three fruit trees or a setting of eggs was not registered. Registration was confined to the man who ordered sufficient material to plant up an appreciable orchard or one who struck the Agricultural Assistant as being particularly keen.

The First Year's Results

During the year after the start of the scheme in September, 1955, a total of 66 farmers in Kuala Langat District were registered. Eleven of these "failed" in one way or another. Their cards are now pending, that is to say they are no longer given detailed attention, but if at a future date they should show more interest, follow up will be resumed. Some reasons for failure may be of interest.

"A". Supplied 80 rambutans—made a good start and later sold his land.

"B". Poor character, not sincere.

"C". Husband did not agree to laying down of demonstrations.

"D". After a deal of effort, involving the Assistant Veterinary Officer as well as the Agricultural Assistant, owner sold all his selected goats at *Hari Raya*.*

"E". Sickness.

Others either left the District or simply did not respond to attention.

Nineteen of the registered farmers occupy an intermediate position. They have not failed, but the progress they show is not sufficient to justify intensive effort.

Thirty-six of the farmers originally registered have well repaid the attention given to them. Contact was established with these people at various times between September, 1955, and September, 1956, and a few of them were known to Departmental staff before September, 1955. Each of these 36 farmers has been visited at regular intervals since the register was started. Altogether, 340 individual visits were made to the 36 special registered farmers during the 12 months, 32 visits were paid to those 11 who fell by the wayside and 46 to the 19 farmers in the intermediate category: a total of just over 400 individual visits by the Agricultural Assistant in the year. This is an impressive effort on the part of the Agricultural Assistant in charge of the District, representing something of the order of 1.3 visits per working day, and is probably the maximum effort that can be applied with the existing staff, taking into account the demands of other duties.

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* A Muslim festival.

PLATE I

Registered farmer's house. Compound fully developed with coffee and fruit. (Che Puasa bin Ismail).

PLATE II

Neglected house adjoining the compound shown in Plate I.

PLATE III

Group of registered farmers at Sijangkang. The crop is Liberica coffee planted under coconuts.

PLATE IV

Gliricidia planted for mulching coffee on a registered holding.

It would be tedious to detail what has been done in each case. The registered farmers are of all races; one of the most successful is an aboriginal, the Batin* of the group at Bukit Bangkong. Their interests and the topics on which advice has been given include poultry, goat and pig rearing, coffee planting, fruit tree and pineapple planting, coconut improvement, manuring, mechanised cultivation, agricultural courses for the family, pest control, etc. One of the farmers is an ex-labourer from the Telok Datoh Agricultural Station who was dismissed for inefficient service; he has certainly made a better showing with his own enterprise than he ever did with the Department's poultry flock at Telok Datoh.

As well as visiting the selected farmers at regular intervals, the Agricultural Assistant has organised visits by them to agricultural stations, to other progressive farmers and to other places of interest, e.g., in the case of pineapple growers, to the pineapple cannery. Several of the farmers have been on short two-week courses at Cheras Agricultural Station. They have been used by the Agricultural Assistant for disseminating information both indirectly, by passing ideas on to their friends, and directly by convening meetings at which talks have been given. All these activities have been most profitable to both sides of the partnership.

The farmers' register has been tied in with other aspects of the extension effort. Courses for village youths have been concentrated largely on those villages where there is a concentration of interested farmers. Through their co-operation a better type of student is obtained and the follow-up of these lads after training is greatly facilitated.

A Review of the Results

It has become very evident that the policy of concentrating effort on a few selected farmers is the right one, certainly so long as extension staff is limited. The co-operation received from the 36 registered farmers is really remarkable. These men have already become, in effect, unpaid extension workers. Their holdings are demonstrations and they themselves are a link between the Department and the mass of village people. An account of a visit paid to Sijangkang in late 1956 will perhaps illustrate how effective the method is. Officers of the Department called successively on four of the registered farmers. As they went from one holding to another the party grew and when they arrived at the last holding all four farmers were present and engaged in animated discussion. Several requests for assistance from other people in the village were passed on to the Agricultural Assistant. It appeared to be recognised that the registered farmers in Sijangkang were an adequate channel of communication with the Department.

Experience has shown, as might be expected, that it is of no use trying to force attention on farmers. The best results are achieved where the initiative both in the initial contact and at later stages comes from the farmer.

The register is only one weapon in the extension worker's armoury,

* Headman.

but at the present stage it is the most important and it is being used as the foundation on which other extension methods are based. Lectures, film shows, bombardment with pamphlets and agricultural courses do little without real practical achievement by the farmer on his own land, which will serve as demonstration to others. If there is a living example of what can be achieved, propaganda has a real meaning. The effect of the extension worker's effort is many times enhanced by the "corps" of voluntary helpers which the registered farmers constitute.

During the first year's operation the system has achieved, without any doubt, its main object of enabling the Agricultural Assistant to plan his work and to avoid wasting his time on unprofitable material. Continuity of the work is assured. Really thorough "follow up" has been achieved in a limited number of cases, but owing to the limited staff available it has not been possible to follow up in detail every contact made. The greatest achievement of the system, and one which was not foreseen when it was started, has been the development of a nucleus of progressive farmers in various centres who are, in effect, voluntary workers on behalf of the Department's extension effort.

It is the intention to multiply considerably the number of extension workers in the field by the recruitment of Junior Agricultural Assistants. When this happens it will be possible to follow up in detail a larger number of farmers. Each of these workers will be allotted a small section of the register on which he will concentrate, probably, in view of his limited training, on somewhat restricted lines. The existence of the register will enable the Agricultural Assistant-in-charge to direct efficiently the work of his subordinates in the same way as it has assisted him to plan his own work. It will ensure continuity of attention when staff changes have to be made.

Acknowledgements

My thanks are due to Enche Zakaria bin Abdul Raof, Assistant Agricultural Officer in charge of Klang/Coast Circle, to Enche Abu Bakar bin Ali Basha, Agricultural Assistant, Kuala Langat, whose hard work and single minded purpose have made the essential contribution to the success of this scheme, and last but not least, to the registered farmers themselves for their willing co-operation.

AREA	K.Lgt:/5	Date	Supply of Material Etc.
NAME	Dewam bin Kasidin,	July '55	- Supplied 2 gals. of 2.4.5.T for poisoning old rubber.
ADDRESS	Kampong Chodoi, P.O. Banting.	15/10/56	- 1 yd. of R.10 budwood for trial budding of 6 rambutan seedling plants.
SOIL	Light-clay,		
INTERESTS	Rubber Fruit Coffee. Agric.Course. Manuring. Replanting.		

FOLLOW UP AND VISITS

Date		Date	
Aug.55	Old rubber trees completely died.	3/4/56	Visited holding and normal discussion on poultry and general subjects.
17/10/55	Went for agric. course at Cheras to be back on 28/10/55.		
29/10/55	Visited and discussed the course.	20/4/56	Invited S.O. to visit land and discussion.
28/11/55	Advised to commence poultry keeping on a modest scale at beginning.	12/7/56	Visited office and saw budgrafting of rambutan plants.
30/11/55	Visited holding; advised using Gammexane on coffee infested with ants; Powder to be given.	Sept.56	Normal discussion while visiting holding.
12/12/55	Visited T.D. on invitation; showed poultry management at Station; advised Gammexane spraying on coffee infested with ants. To assist getting powder. (continued).	15/10/56	Discussed budgrafting and supplied with 1 yd. of R.10 budwood. 1 Y.V.22/10.
		17/10/56	With S.A.O. to visit Sg. Buaia and met Dewam.

AREA	K.Lgt./8	Date	Supply of Material Etc.
NAME	Puasa bin Ismail	16/4/55	Supplied 1 packet Agrocide; Agric. leaflets.
ADDRESS	17th Mile-Sungei Manggis, Kuala Langat Banting P.O.	12/9/56.	2 budded rambutan supplied.
SOIL	Clay - well drained.		
INTERESTS	Poultry Rubber Fruit Coffee. Agric.Course. Pamphlets. Manuring. Replanting.		

FOLLOW UP AND VISITS

Date		Date	
	Taught preparation of kerosene emulsion; budgrafting of rubber rambutan; advised use of fertilisers.	7/11/55	Drain laid out as advised; pepper to be re-established when convenient.
		12/11/55	Visited fruit orchard at Telok Bunut and collected rambutan and nangka seeds for station; showed method of selection of fruit trees.
Feb.55	Appd.Rep.grant for 1 acre coffee. Advised methods of cultivation and maintenance.		
19/8/55	Advised trial planting of pepper;pepper-cuttings 100 supplied.	10/1/56	Normal inspection & discussion.
		Feb. 56	Casual inspections & discussions.
20/8/55	Assisted establishing pepper.	17/4/56	Stagnant H_2O at back; advised drainage; front portion of land to be planted with sugarcane due to close proximity to drain.
14/9/55	Helped establish rambutan nursery; + 200 seedlings estabd.		
6/10/55	Growth of rambutan seedlings good;pepper not doing well being constantly under water.	22/5/56	Arranged visit of 21 A.A. Ref. Course trainees.

Caxton K.L.—16343/3-56.

SOIL SURVEY REPORTS. NO. 5, THE FEDERAL EXPERIMENT STATION, JERANGAU, TRENGGANU

BY

WM. P. PANTON,

Geologist (Soil Survey)

Introduction

The Federal Experiment Station at Jerangau, Trengganu, is a recently opened experiment station, the site of which was specially selected to be representative of one of the main soil groups and climatic zones of the Federation of Malaya. Cacao cultivation is being given priority at this station, which is situated in the centre of a large area of jungle-covered land, suitable for future commercial plantings of this crop.

The field work on which this survey report is based was carried out during the first two weeks of May, 1955. Although the greater part of the station area is at present covered by virgin jungle, it was possible to carry out a detailed soil survey by making traverses along a network of traces, spaced at intervals of four chains, which had been prepared for a detailed topographic survey. Soil examination at one chain intervals along the traces was carried out using a 3 ft. soil auger, and the soils were classified according to series established in a reconnaissance survey carried out in the region during the previous year. Mapping has been done at the series level, and five different soil series have been identified. In addition, the waterlogged valley soils have been shown as occurring as a large undifferentiated group of immature soils with poorly developed profiles.

Soil Forming Factors

The soil forming factors operating in the area are briefly summarised below.

CLIMATE

This is characterised by a very high rainfall which is markedly seasonal. Average yearly precipitation is around 150 in., the greater part of which falls in the monsoon months between November and February. During the past three years (the only years for which rainfall figures are available), a monthly maximum of 43 in. (in December) and a monthly minimum of 1 in. (in March) have been recorded. Humidity and temperatures are high throughout the year, with slight seasonal variations due to the monsoon influence. Nights are normally rather cool.

GEOLOGY

All the soils occurring within the station boundary are derived, either directly or indirectly, from igneous rocks, ranging in composition from granite to quartz diorite. The rocks are generally deeply weathered and undecom-

posed specimens are difficult to obtain. However, correlations between the various types of igneous rock and the soils have been made in other areas during reconnaissance survey work, and, by interpretation from the soil map, a fair picture of the geology can be obtained. This indicates a gradual change from granodiorite as the dominant constituent near the road to normal granite on the eastern side of the station. Outcrops of quartz diorite also occur within the main granodiorite mass, particularly in the area shown on the western side of the map.

Topography

The topography is gently to moderately undulating, the hill country being dissected by numerous, small, flat-bottomed swamp valleys most of which trend north-west to south-east. These valleys may indicate weathering along lines of weakness in the granitic parent material. On the other hand, some of the smaller valleys show a general orientation on a west-south-west to east-north-east line, which coincides with the dominant regional fault trend, thus indicating weathering by stream erosion along the actual faults.

Vegetation

At the time of survey most of the area was under virgin forest, with chengal (*Balanocarpus heimii* and *Hopea* spp.) on the hill soils and swamp forest on the alluvial flats. Some 50 acres close to the road near the western side of the station is at present under cultivation, part with cacao under thinned forest shade and part with oil palm in cleared jungle.

Soils

A classification worked out in 1954, during a reconnaissance soil survey of an area a few miles to the north of the station, was used in this survey, as the same soils were found to occur over the station. These soils are described in the following paragraphs.

Rengam Sandy Clay Loam

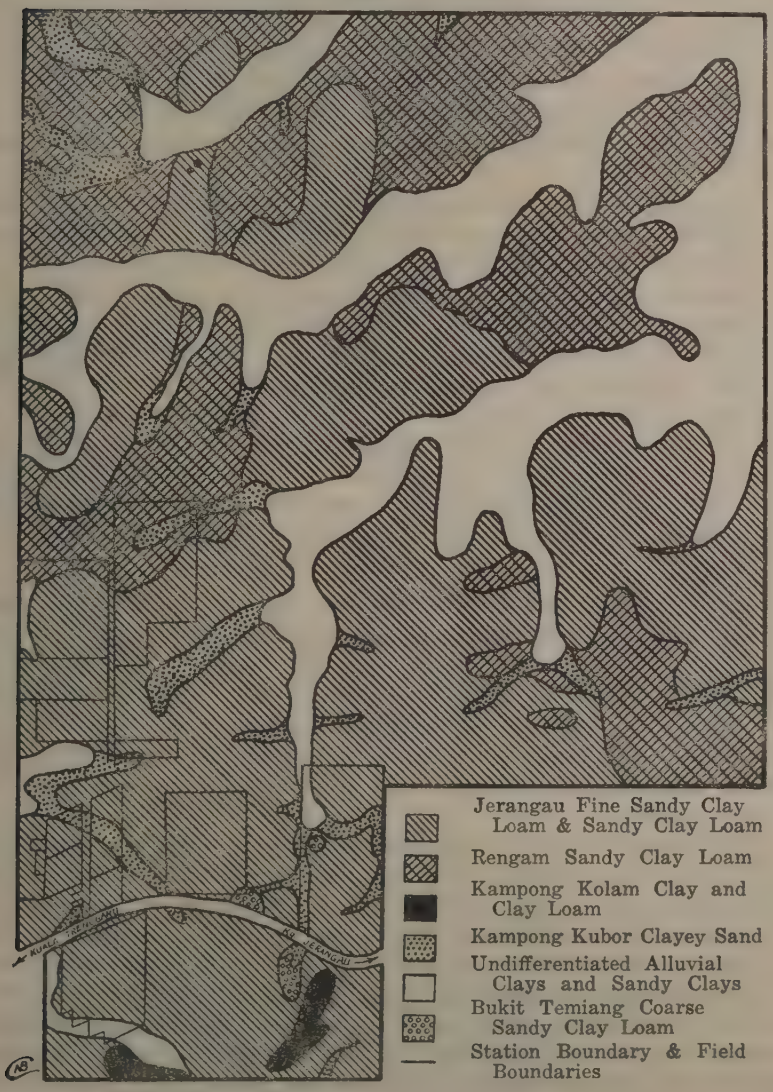
The Rengam sandy clay loam is one of the most commonly occurring soils in Malaya. It is developed from normal granite rock in undulating land and can often be seen well exposed in road cuttings in many parts of the country. It was first described by Owen (1) as "a reddish-yellow, friable, sandy clay loam, often micaceous. Occasionally a gradual colour change from yellow to yellow with red mottling, and finally to a uniform pale red colour, can be observed within 6 ft. from the surface, but usually the uppermost reddish-yellow horizon is much deeper".

Within the station boundary the surface soil, which is normally only an inch or two in thickness when seen under its natural cover of virgin jungle, is a dark brown sandy loam or sandy clay loam with a moderately strong, fine crumb. The subsoil is usually more of a brownish-yellow than reddish-yellow in colour, has a sandy clay loam texture and possesses a friable, moderately strong, fine subangular, blocky structure, well drained and with good aeration which permits of deep rooting. This subsoil horizon is normally

SOIL MAP

FEDERAL EXPERIMENT STATION JERANGAU

SCALE 20.8 CHAINS TO AN INCH


Jerangau Fine Sandy Clay Loam & Sandy Clay Loam
Rengam Sandy Clay Loam
Kampong Kolam Clay and Clay Loam
Kampong Kubor Clayey Sand
Undifferentiated Alluvial Clays and Sandy Clays
Bukit Temiang Coarse Sandy Clay Loam
Station Boundary & Field Boundaries

at least 4 ft. thick and, apart from a slight compaction at depth, shows remarkable uniformity; roots are often well distributed even as far down as 5 ft. Below 5 ft. there is a gradual change to a firmer, pale red sandy clay loam which becomes progressively coarser as the parent rock is approached.

The soil covers about 280 acres, mainly in the gently to moderately undulating land towards the north-east boundary and does not occur in any quantity near the main road. It is found mostly on slopes of between 3° to 4° and 15°, but may sometimes be developed on slopes up to 30°, in which case it is generally transitional to Bukit Temiang Series (see below).

Although there is no planting of cacao on this series within the station, the soil appears to be suitable, and there is no reason to suppose that plantings will not be successful.

As can be seen from the analysis details in Table I, which were obtained from a typical profile pit, the available phosphorus is low, while the available potassium content is reasonably high, at least in the topsoil.

Lateritic phases of this series, as well as of the Jerangau and Kampong Kolam Series, are to be found within the station, but they are of very limited extent and are not present in mappable quantities. They occur mainly around the bottom of slopes, particularly very gentle slopes of 3° or 4°. The laterite band, however, seldom occurs near the surface and is generally found at a depth of 3 ft. or more. The laterite is not compact, and in the few instances where such a band has been seen in pits dug in these soil series in other parts of the Jerangau region, tree roots were normally able to penetrate through the band, which is generally less than 12 in. thick.

Jerangau Fine Sandy Clay Loam and Sandy Clay Loam

This well-structured, deep, fertile soil is, in appearance, not unlike the Rengam sandy clay loam but differs chiefly in possessing a rather heavier texture, lower colour value and more strongly developed structure. It is probable that this soil is derived from a less acidic rock than the normal granite which is so typical of the mountain ranges near the west coast, and is likely to have been formed from a deeply weathered, fine grained, hornblende granite or granodiorite, of which there are considerable quantities in the east coast ranges.

The surface soil, which is only an inch or two deep, is a dark brown sandy clay loam or fine sandy clay loam with a moderately developed fine crumb of friable consistency. This is underlain by a one- or two-inch transition layer with a moderately strong crumb structure and colour varying from brown to yellowish-brown. Drainage and aeration is normally very good and roots are well distributed and numerous throughout the topsoil. The subsoil is most commonly a fine sandy clay loam but may vary in texture from sandy clay loam to clay loam. It has a characteristicly strong brown colour and a strongly developed, fine subangular, blocky structure with firm consistency. The soil is well drained and permits of good root development down to a depth of 5 ft. or more. At greater depth the soil becomes firmer, the colour changes to yellowish-red and the texture may become coarser.

Table I

Federal Experiment Station, Jerangau

Analysis of Rengam Sandy Clay Profile

Depth (in.)	Clay <.002 mm.	Silt .002 –.02 mm.	Fine Sand .02–.2 mm.	Coarse Sand .2–2 mm.	Gravel 2 – 10 mm.	Stone in Orign. >10 mm.	pH	Loss on Ign. (%)	O.M. (%)	C (%)	N (%)	C/N Ratio	Available Nutrients	
													P* (p.p.m.)	K† (p.p.m.)
0 - 1	16	10	35	39	Nil	Nil	4.2	12	5.4	3.11	.30	10.3	3	55
1 - 2	16	10	36	38	„	„	4.2	9	4.1	2.37	.28	8.4	2	30
2 - 5	18	10	33	39	„	„	4.2	6	1.6	0.90	.14	6.3	1	30
5 - 12	28	10	24	38	„	„	4.5	7	0.3	0.17	.10	1.8	Trace	10
12 - 20	28	9	28	35	8	„	4.3	8	0.5	0.30	.09	3.3	„	20
20 - 30	37	10	27	26	13	„	4.6	9	—	—	—	—	„	15
30 - 44	32	8	32	28	11	„	4.6	6	—	—	—	—	„	20
44 - 74	45	10	20	25	44	6	5.1	6	—	—	—	—	„	8

* Available phosphorus by extraction with ammonium fluoride and HCl at pH 1.8 followed by colorimetric estimation.

† Available potassium by extraction in N/2 acetic acid (ratio 10:1) followed by estimation in the Langé flame photometer.

This soil occurs chiefly on the western side of the station bordering the road, and is particularly well developed in the vicinity of the station buildings. Parts of it have already been planted with cacao which has established itself well and is showing very satisfactory growth.

Transitional soil types between the Jerangau Series and the Rengam Series are rather common, indicating a gradual change in rock composition from west to east. The transitional soils are particularly common along the main soil boundaries, which are generally rather indistinct in the case of the hill soils. The total area of the Jerangau Series amounts to about 440 acres.

A typical set of analysis results obtained from a soil pit dug in this series is given in Table II. Apart from the somewhat heavier texture, the analysis details are closely analogous to those for the Rengam sandy clay loam in Table I.

Table III shows the cation exchange capacity data from samples obtained from a profile pit dug in this series near the north-west boundary of the station. These results, which were obtained by leaching with a solution of barium chloride and triethanolamine of pH 8.1, are similar to those obtained on many other Malayan hill soils, and illustrate the low cation exchange capacity and percentage base saturation of these soils.

Kampong Kolam Clay and Clay Loam

This very deep and very well structured soil occurs in mappable quantity only over a very restricted area on the small section of station land to the west of the main road. Very small patches, only a few square yards in area, do appear spasmodically within the main Jerangau Series outcrop, more especially in the centre of the area. The area of this soil is unlikely to exceed six acres. Soft fragments of weathered rock found in small stream gullies within these areas indicate that the parent material is probably a quartz diorite.

A dark brown clay or clay loam with a strongly developed fine crumb of firm consistency an inch or two thick forms the surface soil. The subsoil is a yellowish-red or reddish-brown clay to clay loam in which root development is particularly good, while the whole profile is well drained and aerated and possesses a strong medium to fine crumb structure for several feet. Roots can generally penetrate down to 6 ft. or more, and the soil is easily dug and well structured to considerable depth.

The large amount of root room, well developed crumb structure and fine texture of this soil indicate that it probably possesses high fertility, and it appears to be particularly suitable for tree crops. It is not unlike the soil occurring near the 12th mile on the Temerloh to Maran road in Pahang, on which cacao is showing excellent early growth: similar success can be anticipated with this soil type, although to-date no cacao has been planted on these areas within the station boundary. Analysis details for a typical profile are shown in Table IV.

Table II

30th Mile Jerangau Road

Analysis of Jerangau Fine Sandy Clay Loam Profile

Depth (in.)	Clay <.002 mm.	Silt .002 –.02 mm.	Fine Sand .02–.2 mm.	Coarse Sand .2–2 mm.	Gravel 2 – 10 mm.	Stone in Orign. >10 mm.	pH	Loss on Ign. (%)	O.M. (%)	C (%)	N (%)	C/N Ratio	Available Nutrients	
													P (p.p.m.)	K (p.p.m.)
0 - 1	14	11	48	27	Nil	Nil	5.2	8	3.6	2.06	0.16	12.9	9	44
1 - 3	16	15	28	41	„	„	5.2	6	2.6	1.48	0.11	13.0	4	33
3 - 7	25	12	38	25	„	„	5.4	6	1.3	0.77	0.08	9.6	8	15
7 - 21	28	23	38	11	„	„	5.4	6	1.2	0.72	0.06	12.0	3	15
21 - 36	35	10	46	9	„	„	5.1	6	1.0	0.59	0.04	14.8	3	7
36 - 48	40	11	31	18	„	„	5.4	5	0.9	0.50	0.06	8.1	1	7
48 - 72	43	20	30	7	„	„	5.3	6	0.9	0.54	0.05	10.8	1	16

Table III

Federal Experiment Station, Jerangau

C.E.C. Analysis of Jerangau Sandy Clay Loam

Depth (in.)	C.E.C. (m.eq./100g.)	Total Cations	Potassium	Calcium	Sodium	Magnesium	Total K+Ca+Na+Mg	Hydrogen	Percentage Saturation
0 - 1	13.9	12.48	0.28	0.30	0.24	0.51	1.33	11.15	9.5
1 - 3	11.7	12.87	0.23	0.20	0.23	0.29	0.95	11.92	8.1
3 - 5	10.4	8.82	0.19	0.16	0.14	0.25	0.74	8.08	7.8
5 - 12	9.75	7.44	0.20	0.15	0.14	0.22	0.71	6.73	7.2
12 - 25	11.10	6.73	0.18	0.13	0.20	0.07	0.58	6.15	5.2
25 - 36	8.6	6.78	0.20	0.15	0.21	0.18	0.74	6.04	8.6
36 - 44	8.4	6.80	0.23	0.18	0.24	0.23	0.88	5.92	10.5
44 - 49	8.4	6.01	0.18	0.16	0.19	0.21	0.74	5.27	8.8

Table IV

Federal Experiment Station, Jerangau

Analysis of Kampong Kolam Clay Profile

Depth (in.)	Clay <.002 mm.	Silt .002 –.02 mm.	Fine Sand .02–.2 mm.	Coarse Sand .2–2 mm.	Gravel 2 – 10 mm.	Stone in Orign. >10 mm.	pH	Loss on Ign. (%)	O.M. (%)	C (%)	N (%)	C/N Ratio	Available Nutrients	
													P (p.p.m.)	K (p.p.m.)
0 - 1	38	19	19	24	21	Nil	4.2	16	7.2	4.16	0.37	11.3	2	100
1 - 4	51	17	15	17	5	„	4.2	13	3.9	2.25	0.22	10.0	1	45
4 - 9	58	15	11	16	Nil	„	4.3	13	2.7	1.56	0.18	8.6	1	30
9 - 17	59	15	12	14	„	„	4.6	12	2.0	1.15	0.11	10.4	1	15
17 - 29	62	13	14	11	10	„	4.7	12	1.4	0.81	0.09	8.7	1	23
29 - 41	65	10	17	8	3	„	4.9	11	1.1	0.64	0.08	8.0	1	5
41 - 53	48	32	11	9	Nil	„	5.2	10	1.0	0.58	0.07	8.3	Trace	10
53 - 65	37	42	14	7	„	„	5.2	12	0.9	0.52	0.06	8.7	„	13
65 - 72	40	43	9	8	11	„	5.3	12	0.9	0.52	0.07	7.4	„	13

Kampong Kubor Clayey Sand

This soil occurs in the smaller valleys where it is formed by the accumulation, as a result of soil creep and local wash, of the coarser material from the surrounding slopes. The profile is rather variable in appearance but the most characteristic features are the high water table, coarse texture and the dark topsoil colour, which changes at varying depth to a pale grey or white.

The surface soil is a dark brown, very weakly crumbed coarse sand an inch or two thick which is underlain by a subsurface horizon of sand or clayey sand, yellowish-brown in colour and with a friable, weak, subangular crumb. The subsoil is generally a light grey, loose, moist sand or clayey sand with slight red mottling, and the water table may vary in depth from 6 in. to 3 or 4 ft.

The fertility of this soil is not high and this is due to a combination of low nutrient levels, poor structure and high water table with occasional flooding.

Improvement of the drainage by ditching may bring about sufficient improvement in this soil to make the cultivation of cacao a possibility, and one small area near the station buildings has recently been planted with this crop.

Bukit Temiang Coarse Sandy Clay Loam

This is a coarsely textured, shallow soil developed from granite and granodiorite over steeply sloping land. It occurs only over a very small area of the station near the main road boundary.

The topsoil is a brown or dark-brown, well rooted, gravelly coarse sand or gravelly coarse sandy clay loam which may be up to 4 in. thick and possesses a well developed granular crumb, beneath which the soil is generally a strong brown to brownish-yellow colour, rather coarser textured and more difficult to dig. Rooting decreases rapidly to a depth of about 2 or 3 ft., below which the presence of large boulders of parent rock or close-packed, decaying granite gravel prevents further root penetration. Irregular red staining or blotching may be present at this transition horizon.

Drainage in this soil is rapid both throughout the upper part of the profile and along the weathered joint planes in the parent material. In spite of this good subsoil drainage, however, the steep slope results in severe erosion during heavy rains, particularly when the natural jungle cover has been removed. Soil wash in such situations rapidly removes the shallow topsoil and the underlying rocks are soon exposed on the surface.

Owing to the rapid release of nutrients from the decomposing rock, the fertility of this soil may be quite high but the susceptibility of the soil to erosion makes it unsuitable for most types of cultivation.

Undifferentiated Alluvial Clays and Sandy Clays

This is a group of mixed soils all having high water tables and liable to surface flooding for long periods during the monsoon season. The soils

are entirely alluvial and the profile generally consists of a dark grey or black surface horizon of clay or mud which is underlain by a rather light coloured, sticky, compact clay or sandy clay.

The natural vegetation consists of swamp forest and the soils are not suitable for cacao. Moderate yields of wet padi could be obtained from this land after clearing of the swamp. Some 230 acres of station land is covered by this soil.

Summary

A soil survey of the Federal Experiment Station, Jerangau, has been completed and a map produced on a scale of 16 chains to 1 inch (the copy accompanying this article has been reduced to 20.8 chains to 1 inch). The soils, three of which are recommended as being suitable for cacao cultivation, have been classified into series which were previously identified during a large scale reconnaissance survey of the region, and descriptions of each of these soils have been included in the report.

Acknowledgements

Thanks are due to Mr. J. R. Paton, Geologist, formerly resident in Trengganu, for much discussion and advice on soil-rock correlation; to Mr. A. L. Barcroft, until recently State Agricultural Officer, Trengganu, and his staff at the Federal Experiment Station, Jerangau, for their material assistance during the field work; and to Mr. G. W. Arnott, Chemist (Soils), for the analysis results and comments thereon.

References

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WET PADI MANURIAL EXPERIMENTS ON PEAT SOILS IN MALAYA

BY

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and

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Introduction

Peat and other bog soils cover large areas of alluvium in Malaya, perhaps more than 1,000,000 acres (404,680 ha.). Where these have been recently cleared of forest the loss on ignition may be as high as 95 to 98 per cent and the pH 3.3 to 4.0, although the surface horizon is often less acid, espcially after the burining associated with dry-land corpping. Similarly, the loss on ignition decreases with progressive mineralization of the surface layers, this being accompanied by shrinkage and subsidence of the surface.

Utilization

Certain dry-land crops, particularly pineapples, can be grown on peat soils quite successfully, but tree crops are not usually successful unless the initial depth of true peat is less than 3 ft. Potash and copper are key elements in pineapple nutrition on peats.

Between 1947 and 1950, attempts were made to grow wet padi by mechanical methods on peat at Chenderong Balai Padi Test Station, Perak, but these were generally unsuccessful and it was then decided to abandon mechanised trials but to continue with fundamental investigations in an attempt to solve the long-term problems of wet padi cultivation on this type of soil. The work was continued at Chenderong Balai and at Padang Kemunting Padi Test Station, Trengganu.

Soil Characteristics

These have already been fully described (1) and soil analysis data are summarised in Table I.

Experiments with Major Elements

NPK Factorial Trial at Chenderong Balai

This trial was laid down in 1951 and continued for three seasons with the object of determining the effect of NPK on the growth and yield of wet padi. The layout consisted of a 2^3 factorial arranged in 10 blocks of four

plots each. Plot size was 33 × 33 ft. (1/40 acre). The treatments tested were:-

N - 47 lb./acre (53 kg./ha.) N as sulphate of ammonia;

P - 166 lb./acre (186 kg./ha.) P_2O_5 as Christmas Island rock phosphate; and

K - 134 lb./acre (150 kg./ha.) K_2O as muriate of potash (KCl).

The phosphate and potash were applied before transplanting and the nitrogen placed in the soil about seven weeks later. A fresh site was chosen for the trial in the third season.

Yields of grain and treatment effects for the three seasons are summarised in Table II. It will be seen that yields were very low in all three seasons but that there was an improvement in the last season, which was associated with improved cultivation and drainage. In the 1952-53 season there was a clear response from phosphate but no other differences were significant.

BLNPK Factorial Trial at Padang Kemunting

This trial was laid down in 1953 in Trengganu on a deep peat soil with the following treatments:-

B - surface peat burnt early in the year.

L - 1 ton/acre (2,511 kg./ha.) ground magnesium limestone applied early in the year.

N - 55 lb./acre (62 kg./ha.) N applied as nitrate of soda, one-third before planting and two-thirds about six weeks later.

P - 40 lb./acre (45 kg./ha.) P_2O_5 as double phosphate applied before transplanting.

K - 30 lb./acre (34 kg./ha.) K_2O as muriate of potash applied before transplanting.

This was repeated in the 1954-55 season on a fresh site. At the same time, the first trial was repeated, for residual effects, with only the burn treatment reapplied.

Harvest yields and treatment effects are summarised in Table III.

In the first season the crop failed because of lack of rain and heavy attack by *Scotinophara coarctata*. Nevertheless, it was possible to detect a significant effect of P, especially in the presence of K, on both straw yield and tillering.

When this trial was repeated on the same site after re-burning the B plots but with no other new treatment, there was revealed a highly significant residual response to P from yields of grain and straw and from tiller number. There was also a small residual effect on yields and tillering from liming.

The same trial on fresh land in the 1954-55 season confirmed the highly significant effect of phosphate and burning on the subsequent yields of grain

and straw and on tillering. The average yields of grain from these treatment combinations were as follows:-

	No Phosphate	Phosphate
	(lb. per acre)	
No burning	15	1710
Burning	866	1800
	±100	

It will be seen that both phosphate and burning have increased yield of grain but both treatments were more effective separately than jointly.

Liming had a small beneficial effect on yield of grain while nitrogen increased the yield of straw by a small amount.

Tillering was increased by the B, P, K and L treatments and both N and K enhanced the beneficial effect of B, whereas the following treatment combinations did not have additive effects:- BL, LN, BP and LK.

From the practical viewpoint, phosphate is clearly all important, while surface burning is beneficial to a lesser extent. This result agrees, to a certain extent, with the observed benefit from phosphate at Chenderong Balai in 1952-53 (vide Table II). It is interesting to speculate as to the reason for the small response at this locality. Was it connected with the use of the water-insoluble rock phosphate or was it an ecological effect? This point is now under investigation.

This very promising result from Padang Kemunting is of very great interest as it is the best padi crop that has ever been grown on peat soil *in situ* in Malaya. It is perhaps important that this station is dependent on rainfall and is well drained whereas Chenderong Balai is irrigated but has very poor water control. It is possible, therefore, that the dissolved oxygen in the soil-water is an important limiting factor of yield on peats.

Observations on shallow peat and muck soils at Parit Satu, in the Tanjong Karang area of Selangor, are also in progress but poor drainage has limited yields there. There is some indication that best results can be obtained by growing a Kelantan dry padi variety on such soil, but, naturally, yields are dependent on rainfall.

Experiments with Minor Elements

Observation at Chenderong Balai

The effects of copper, zinc, boron, manganese and molybdenum have been tested for two seasons in duplicated plots with one set receiving a complete dressing of major elements. The following dosages were used:-

Fertiliser	Quantity per Acre
Copper sulphate	25 lb.
Zinc sulphate	25 lb.
Borax	15 lb.
Manganese sulphate	20 lb.
Ammonium molybdate	10 lb.

All these were sprayed on about seven weeks after transplanting, at the time of application of a nitrogen top dressing. A wetting agent was added to the spray liquids.

The crop was destroyed by pests in the first season and no results were obtained: in the 1953-54 season a fair crop was harvested and yields are summarised in Table IV.

It was observed that the copper spray caused severe scorch, so this element is perhaps best applied as Bordeaux mixture. Copper is known to be essential for the healthy growth of pineapples on dry peat and it is probably also of benefit to coffee on that soil.

Observation at Padang Kemunting

In 1954-55 an unreplicated series of plots was laid down on deep peat after burning and liming and all plots also received NPK. The treatments are given in Table V.

The "fritted trace element" fertiliser is a synthetic sand which is said to release small quantities of trace elements in the soil over an extended period. Each element was applied to two plots systematically to achieve duplication and the results are summarised in Table VI.

The high tillering in the plot which received all elements in spray form was associated with damage by leaf-eating caterpillars and should be ignored.

When the effects of each element are extracted from the figures in Table VI they suggest that copper was perhaps harmful and iron perhaps beneficial. The differences were, however, very small and the chief value of this and other observations was the experience gained in the application of minor elements in spray form.

Factorial Experiment at Chenderong Balai

In 1954 a properly designed experiment was laid down at Chenderong Balai to test the effect of Cu, Zn, Mo, B and Mn using the same chemicals and dosage rates as at Padang Kemunting in the same season. The whole area received 4 cwt. per acre each of Christmas Island rock phosphate and ground magnesium limestone before the last cultivation but no other major elements were given. All the minor elements were applied in spray form, the copper as Bordeaux mixture.

Fritted trace elements were tested in one extra plot in each of the four blocks, so the design adopted was $2^5 + 1$ with nine plots per block.

The simple effects are summarised in Table VII.

The very low yields were associated with stem-borer damage but the results confirm the harmful effect of copper.

This trial is being repeated on a fresh site but there is no indication that the absence of any trace element is a limiting factor of padi yield on deep peat in Malaya. This is in line with results from pot experiments.

Table I

Analysis Data of Soils at Chenderong Balai, Perak, and Padang Kemunting, Trengganu

Site	Depth of Peat or Muck (ft.)	Loss on Ignition (per cent)		pH		Date of Sampling
		0-6 in.	6-18 in.	0-6 in.	6-18 in.	
Chenderong Balai	2½	44	68	5.0	5.1	24. 3.49
Padang Kemunting	9+	51	75	4.2	4.1	15.10.52

Table II

Effect of Treatments on Yield of Wet Padi at Chenderong Balai, Perak

	1951 - 52		1952 - 53		1953 - 54	
	lb./a.	kg./ha.	lb./a.	kg./ha.	lb./a.	kg./ha.
N	–70	–78	–14	–16	–118	–132
P	60	67	262***	294***	–26	–29
NP	46	52	–32	36	102	114
K	48	54	32	36	–30	–34
NK	24	27	–50	56	54	61
PK	14	16	19	21	64	72
Standard Error	±50.167	±56.232	±58.90	±66.02	±80.783	±90.550
Mean Yield	292	327	295	331	795	891

*** = Significance at 0.1 per cent

Table III

Wet Padi Cultivation on Peat Soil at Padang Kemunting, Trengganu
Main Effects and Two-Factor Interaction Effects on Yields
of Grain and Straw and Number of Tillers

	1953-54 Season			1954-55 Season (residual)			1954-55 Season (fresh land)		
	Grain (lb./a.)	Straw (lb./a.)	Tillers (no.)	Grain (lb./a.)	Straw (lb./a.)	Tillers (no.)	Grain (lb./a.)	Straw (lb./a.)	Tillers (no.)
B	Crop Failure	515	2.4	678***	2,610***	9.53***	471***	1,781**	5.13***
L		246	3.0*	155*	474	2.87*	232*	534	1.12**
BL		–523	.2	–21	392	2.45	120	101	–2.25***
N		127	1.4	71	–116	1.82	37	1,453*	55
BN		254	.7	78	–243	.58	–164	–713	3.25***
LN		–134	1.6	34	190	.80		146	–1.59***
P		1,158**	9.0***	633***	1,976***	7.07***	1,315***	6,330***	8.87***
BP		45	.8	9	26	1.88	–381**	–930	–2.64***
LP		254	.5	–65	–362	–2.74	97	–26	.06
NP		209	1.5	19	–41	.44	52	952	.09
K		560	3.8*	–56	–422	.82	67	335	3.52***
BK		–164	–0.4	11	93	1.26	30	–467	1.17**
LK		–209	–1.5	116	437	.78	134	–385	–2.02***
NK		–60	1.0	–9	280	.63	179	654	.68*
PK		627*	3.4*	41	–108	–.83	–7	452	2.55***
SE		±277.22	±1.299	±56.938	±270.81	±1.3094	±99.995	±516.404	±0.2973
Mean		1,188	14.28	796	3,087	13.88	1,098	5,133	12.67

N.B.: Significance at 5%, 1% and 0.1% indicated by *, ** and *** respectively.

Table IV

Yield of Grain from a Minor Element Observation at Chenderong Balai, Perak

Minor Elements	With Major Elements* (lb./acre)	Without Major Elements (lb./acre)
Cu	1,120	800
Zn	1,010	850
Mo	1,220	850
B	1,180	970
Mn	1,540	960

* The same fertiliser mixture was used as in the Major Element factorial trial at the same locality.

Table V

Experimental Treatment in a Minor Element Observation at Padang Kemunting, Trengganu

Element	Fertiliser	Rate of Fertiliser per Acre (lb./acre)	How Applied
Cu	Copper sulphate	12½	as spray
Mn	Manganese sulphate	20	„ „
Fe	Ferrous sulphate	15	„ „
B	Borax	15	„ „
Zn	Zinc sulphate	15	„ „
Mo	Ammonium molybdate	10	„ „
All six	All	all	„ „
All	"Fritted trace elements"	100	to soil

Table VI

Harvest Data from a Minor Element Observation
at Padang Kemunting, Trengganu

Treatment	Yield of Grain (lb./acre)	Yield of Straw (lb./acre)	Tillers per Hill (mean)
Zn + Cu	1,440	6,300	12.0
Cu + Mn	1,620	7,920	13.2
Mn + Fe	2,340	7,380	10.6
Fe + Mo	1,980	7,920	12.0
Mo + B	1,800	7,740	10.5
B + Zn	1,980	8,280	13.0
All	1,800	8,820	17.1
All fritted	1,620	6,480	11.9

Table VII

Effects of Minor Elements on Padi
at Chenderong Balai, Perak

Element	Effects (lb. per acre)		
	Grain	Straw	Tiller Number
Cu	–204**	–325 N.S.	0.425
Zn	–86	159	–0.05
Mo	–107	98	0.65 N.S.
B	–6	83	–0.05
Mn	31	–250	–0.162
S.E.	±61.7644	±212.2998	±0.3270
Mean	410	2.340	7.99

** = Significance at 1 per cent.

Summary

1. Peat and muck soils probably cover more than 1,000,000 acres of alluvium in Malaya.

2. Early attempts to grow padi on peat soils were not successful, perhaps because of difficulties of water control and anaerobic conditions in the soil-water.

3. At Padang Kemunting, Trengganu, which is dependent on rainfall for its water supply, the peat is over 9 ft. deep with a pH of 4.1. Experiments here have shown that double superphosphate (40% P_2O_5) and surface burning both increase yields of grain and straw and they also stimulate tillering. Yields of up to 1,800 lb. of grain per acre (2,018 kg./ha.) were obtained in 1955 with these treatments.

4. At Chenderong Balai, Perak, where the peat is shallower and less acid and the land irrigated, yields have usually been poor, but here also a response to phosphate (rock phosphate) has been detected. It is suggested that anaerobic conditions limit growth and yield.

5. For certain dry land crops growing on peat, spray applications of copper, as Bordeaux mixture, are beneficial; for padi, added copper is unnecessary and may reduce yields.

6. There is evidence to suggest that other minor elements (e.g. Zn, Mo, B and Mn) are of benefit to padi growing on peat.

Reference

(1) Coulter, J.K. (1950): "Peat Formations in Malaya"—*Malay. agric. J.*, **33,** 63.

NOTES ON CURRENT INVESTIGATIONS AND EXTENSION WORK OCTOBER TO DECEMBER, 1956

Weather

Very heavy rain fell in Trengganu and Kelantan, causing considerable interruptions in communications, but no serious agricultural damage was reported although there were localised floods of short duration. More serious floods occurred in southern Johore but their effect on crops was not great.

In Negri Sembilan, flooding of padi land in narrow valleys caused some damage to the crop.

Elsewhere, the weather was seasonal with very dry weather in the north-west.

Padi

RESEARCH

Trials of Kedah varieties in Kelantan are promising in that certain selections of the Kedah varieties Subang Intan and Radin China are out-yielding local Kelantan varieties and are in demand by planters.

With the acquisition of additional land at Telok Chengai, Kedah, under the Draft Development Plan, the padi hybridisation programme is now being speeded up and crosses to combine valuable varietal characters and eliminate defects are now being carried out between the varieties Engkatek (high yield and short, strong straw), Radin Kling (high yield, short term, off-season), Seri Raja (high yield, disease resistant) and Siam 29 (high yield, high quality, weak straw). Other strong-strawed varieties, of value both generally and for mechanical cultivation, are appearing in selections of Siam varieties and from seed treated with X-rays.

Selection of improved varieties is proceeding according to plan. In the current season extension trials of the new variety Nachin 39 are being conducted in coastal Malacca, and next year similar trials will be laid down with new, improved strains of Radin Ebos in Kedah, Mayang SaBatil and Seraup Kechil in Penang and Krian and Serendah Kuning in inland districts of Malacca. These extension trials, in which the new varieties are grown on cultivators' land over extensive areas, are the first stage in the distribution of the seed to the planter. A third consecutive extension trial of new Serendah Kuning selections in Negri Sembilan has confirmed the superiority of these strains over the commonly grown ones.

Stem-borers are causing less damage this season than they did last year. Nevertheless, investigations into their distribution, severity and control are being continued and the possibility of breeding borer-resistant padi varieties by crossing commercial varieties with the Malayan wild rice *Oryza ridleyi* is being investigated.

Varietal improvement work by pure line selection has been commenced on the semi-dry varieties which occupy some 50,000 acres of land in Kelantan and Trengganu.

Agronomic Investigations

Growth of experimental padi crops was generally good. There was slight damage by stem-borers and rats in Negri Sembilan. The Padi Test Station at Sala Kanan, Kedah, was the only station on which crops suffered severe rat damage. Birds and pigs caused damage to trials in Johore.

A rapid and marked response to manuring with superphosphate was observed on granite wash soil in Kelantan, and in parts of Johore. There was however less noticeable difference between growth responses to superphosphate and rock phosphate on the heavier soils and the bris of the East Coast. In Trengganu, superphosphate was most effective in improving growth on the lighter soils. Here, also, seedlings from double-sized nurseries, manured with mono-ammonium phosphate and well rotted cattle manure, benefited greatly from field applications of NPK mixtures.

Extension Work

Crop prospects in the north-west are excellent: yields from the current harvest up to the end of December were reported to have averaged 470 and 400 gantangs (gallons) per acre from Kedah and Perlis respectively.

Satisfactory yields were obtained from the padi "menghulu" crop in Kelantan in spite of the fact that the usual weather conditions made harvesting difficult. Growth of the main crop in the north-east was generally satisfactory.

In Kelantan, a further 677 tons of subsidised fertiliser was sold. There is no subsidy in Trengganu although both states are in the same ecological zone and comparable benefits from fertiliser can be expected. That the people themselves realise the value of manuring is shown by the fact that sales of unsubsidised fertiliser in Trengganu totalled 51 tons in 1956.

Fertiliser subsidies are also in force in Negri Sembilan and Malacca. Quarterly sales in Malacca amounted to 68 tons, whereas in Negri Sembilan sales were disappointing and totalled only 61 tons for the whole year.

A total of 4,519 gantangs of selected padi seed was distributed together with 1,327 lb. of rat poisons.

Rubber

The following amounts of planting material were distributed during the quarter:-

Rubber Budwood			Clonal Seedlings	
New Planting (yd.)	Replanting (yd.)	Surplus Destroyed (yd.)	New Planting	Replanting
17,585	60,163	27,443	1,375,784	4,789,427

By the end of the year 13 million clonal rubber seeds had been collected and distributed to nurseries for next season's planting programmes.

Applications for new land for rubber planting have been stimulated by press publicity given to the possibility of financial aid being available under schemes sponsored by the Federal Land Development Authority. In Pahang, for instance, it was reported that the increase in inspection and

certification duties of the Department's officers was giving rise to concern since the acreage involved is about double the 1955 figure while it has not been possible to increase the staff.

The Rubber Industry Smallholders' Planting Material Scheme, 1956, came into effect in September and all budwood nurseries and new clonal seedling nurseries were taken over by the operators of the Scheme. Responsibility for the field maintenance of the Scheme's nurseries remains with the Department and has placed an extra administrative load on all officers concerned.

A surplus of 5,000 clonal seedling stumps was exported to Sarawak.

Cacao

Research

The second of a series of trials to compare 90 selected Trinitario clones was established at the Federal Experiment Station, Jerangau, Trengganu. At the same station the fifth of a series of six exploratory progeny trials was planted. This will involve comparison of selected Criollo, Trinitario, Amelonado and Upper Amazon parents in all suitable combinations.

Agronomic Investigations

The lower parts of the Federal Experiment Station, Jerangau, Trengganu, were flooded during the rains in November and December but no damage was caused to the cacao crop. Flowering had finished by the end of October and maximum harvesting was done in the wetter months of November and December. Altogether, 2,294 pods were harvested—a higher yield than for the corresponding period of 1955.

Approximately 3,000 Amelonado seedlings were planted on the station and another 10,357 were supplied for the State's seed gardens and the pilot scheme for smallholders. The application of magnesium limestone continued to give beneficial effects on growth. In the 17-acre Establishment Trial, 4½ acres was planted under various types of cultivated shade.

At the Federal Experiment Station, Serdang, a new root stock trial was laid down in October. A total of 5,927 pods of all varieties was harvested; the Trinitario generally gave better pod yields than Criollo and Amelonado. Better yields were also obtained from budded plants than from plants raised from cuttings.

In an attempt to reduce mammalian pest attack, a new rodent repellent was applied to ropes which were suspended along the forest edge. It failed to keep musang and monkeys away from the cacao fields.

Extension Work

In the Jerangau Pilot Scheme, planting of the first 24 acres was commenced in October and completed by the end of November. The health of the planted seedlings was satisfactory since the correct degree of forest shade had been provided.

At Landas Estate, a new property opened up this year in Trengganu, 124 acres was planted with Amelonado cacao during the quarter under favourable weather conditions. The deterioration of the road to this estate during the north-east monsoon season gave rise to considerable concern.

Coconut

A search at the Federal Experiment Station, Serdang, failed to reveal the breeding grounds of *Oryctes rhinoceros* beetles, which continued to attack experimental coconut palms there.

In a manurial experiment on smallholders' land in Trengganu, a mixture comprising sulphate of ammonia, rock phosphate and muriate of potash considerably increased yields of nuts. During the quarter the area receiving fertiliser at the rate of 1 lb. mixture per palm per year yielded 1,707 nuts, the area manured at half this rate gave 817 nuts and the unmanured area yielded only 371 nuts.

A Working Committee has been set up with the following terms of reference:-

> "to collect and review existing agricultural and economic data on the coconut industry and make recommendations for the improvement and development of the industry."

The Assistant Director of Agriculture (Field) is one of the four members of this Committee, which has met twice.

Oil Palm

Several trials on estates planted with Dumpy progenies are now in cropping and it appears that the Dumpy types take about one year longer to come into bearing than the Tall Deli types. It remains to be seen whether the later maturing will be offset by higher yields or other factors as the Dumpy reaches maturity.

The launching of a scheme in the middle of the year to provide increased facilities for production of improved oil palm varieties by co-operation between four estates and the Department has given considerable impetus to work on improving oil palm varieties. A further trial to compare Dumpy seeds and dura material was planted and successes were planted on the four co-operating estates with the object of establishing 200 acres of selection blocks in the next three years.

Nutritional work by the leaf analysis method has been continued on oil palms and has helped show the Dumpy has a higher magnesium requirement than the Tall dura is being investigated. Very considerable differences in manurial uptake on different soils have been found; the ash content of the leaf of palms on coastal clays is about twice that of palms on inland soils, and in particular, the manganese content of palms on coastal clays is often five to six times as great as that from palms grown on peat.

Pineapple

A serious crisis occurred in the pineapple industry at the end of December with strikes by workers in factories in Johore Bahru and Singapore. This together with an increase in unsold stocks of canned fruit, resulted in the loss of many tons of pineapples to the farms. The increase in stocks was caused partly by the opening of the Suez Canal and partly by reduced sales in the United Kingdom.

RESEARCH

The pathogen responsible for both heart rot and fruit collapse has been shown to be the same strain of *Erwinia carotovora*: it is pathogenically distinct from the strains causing soft rot of carrot and other vegetables.

Studies on pineapple nutrition by analyses of leaf and fruit tissues have shown that there is a close positive correlation between the amount of potash fertiliser applied to peat soil, uptake of potassium by the plant and the quality of the resulting fruit. The relation varies according to variety and to the nitrogen and phosphorus status of the plant and soil. There are indications that the potash phosphorus ratio in the leaf may be critical in relation to fruit quality. This and the potash, nitrogen and phosphate interactions will be studied further as they promise to offer an easily measurable and objective basis for determining fertiliser requirements.

AGRONOMIC INVESTIGATIONS

Trace element, manurial spraying, fruiting and decrowning, shading and mulching trials continued at the Federal Experiment Station, Jalan Kebun, Selangor. In addition, observations on fruiting control with hormones and calcium carbide were in progress.

Considerable discoloration, similar to the reddening and yellowing of mealy bug attack, occurred throughout the Trace Element Experiment. Mottling was also prevalent.

Plants in the control plot in the Mealy Bug Experiment showed patches of yellow and red wilting. No comparative differences in vegetative growth appeared in the trials of dry and spray application of fertilisers. In the mulching trial, unmulched plots had to be weeded at about two months after planting; mulching delayed weed growth somewhat.

It was observed that the use of beta-naphthoxyacetic acid did not delay maturation of Singapore Spanish or Sarawak pines brought into bearing by alpha-naphthaleneacetic acid or calcium carbide. Calcium carbide treatment produced over 94 per cent flowering compared with 82 per cent produced by alpha-naphthaleneacetic acid treatment.

Other Fruits

A study of the time of bud differentiation in rambutans was started at Serdang. Various rootstocks were tested there for use with citrus and rambutan scions, and small scale work continued at the same station on the practicability of using nucellar seedlings as a means of propagating good mandarin orange clones.

Mandarin oranges growing in the Segamat area of Johore gave the very high average yield of 150 pikuls of fruit per acre from the harvest in September and October.

A trial consignment of 476 grapefruit which was sent from Kedah in December for sale in Kuala Lumpur realised $138.50, or 29 cents per fruit. It would seem, therefore, that there would be no real obstacle to self-sufficiency in supplies of this particular fruit as the quality is comparable with that of the imported product.

Totals of 23,170 clonal fruit trees and 191 seedlings were distributed during the period under review.

Tea

In an observation trial at the Federal Experiment Station, Serdang, polythene appeared to be a fairly satisfactory replacement for resam (*Gleichenia linearis*) as a shade for tea rooting beds. The frame and technique for supporting the polythene will need further improvement.

Food Crops and Vegetables

Rust of maize, caused by *Puccinia polysora*, is now known to have been present in Malaya for the past six years but no reports of damage to the crop have been received during this period. Though it is not at present a serious disease, resistant varieties of maize have been introduced from East Africa as a reserve for use or breeding if the need arises.

The Raja Hitam area of the Dindings in Perak is rapidly becoming a centre for tapioca cultivation and two new factories have recently been erected there.

Some very successful manurial demonstrations were carried out by the Department in vegetable growing areas of the Cameron Highlands where growers demand a fertiliser mixture containing organic manure. The use of the mixture should not cause as large an increase in the fly population as that following application of prawn dust. The mixture used in demonstrations had the following components:-

prawn dust	30 per cent
groundnut cake	25 ,, ,,
sulphate of ammonia	5 ,, ,,
Christmas Island rock phosphate	35 ,, ,,
muriate of potash	5 ,, ,,

Growers have already used about five tons of this fertiliser and the demand for it is increasing. It costs $280 per ton, which is considerably cheaper than prawn dust.

Pepper

"Wilt Disease" is occurring more frequently in gardens in the Kelapa Sawit and Bukit Batu areas of Johore. Active research on this complaint is in progress in Sarawak.

Pasture and Fodder

Analyses of the foliage of the recently imported Russian Comfrey (*Symphytum peregrinum*) have shown the leaves to possess a high protein

content and this plant should prove a valuable fodder crop at the higher altitudes of Malaya.

Five varieties of Guinea grass (*Panicum maximum*) received from East Africa grew remarkably well in experiment plots at the Federal Experiment Station, Kuala Lumpur.

At Serdang, *Panicum trichocladum*, a pasture grass, gave a yield of 10 tons per acre after 45 days' growth and another yield of nine tons per acre 48 days later.

Brachiaria brizantha produced seed in Kedah but it was not viable.

Tobacco

A relatively high quality grade of sliced tobacco—*tembakau hiris*—is grown and prepared at Kampong Tasek, Trengganu, where the product is retailed at $2.50 per tahil (about $1.87 per oz.), which makes it more expensive than pipe tobacco imported from Europe. It has a strong flavour, which is not appreciated by everyone, and its appearance and aroma are good but the burning quality is inferior.

A survey of the Federation's tobacco industry has been completed with a view to determining how the quality can be improved. However, the new excise duty imposed in November, 1956, will automatically discourage cultivation where soil and climatic conditions are not completely favourable to the crop. It is thought, therefore, that cultivation will eventually be restricted to the more seasonal territories of the north of Malaya. It should be noted that the duty on raw and leaf tobacco is $66 per pikul (133⅓ lb.). which is greater than the value of much Grade III cured leaf.

As a result of flood damage to 343 acres of tobacco grown as a catch-crop with young rubber, the Perlis Government made a free issue to growers of some $8,000 worth of fertiliser as a relief measure and to encourage replanting.

Soils

With the creation of State and Settlement Land Development Boards, an increasing number of requests is being received for soil surveys of areas scheduled for agricultural development. Three such surveys over areas of a few thousand acres have recently been completed in Kelantan, Trengganu and Negri Sembilan. Large scale (5 in. to the mile) maps have been prepared and recommendations made as to the suitability of the soils for development with various crops.

A map is being prepared from aerial survey and other data available of all the flat land in Malaya which is topographically suitable for growing padi. This should provide the basis for a more precise estimate of undeveloped, potential padi land than has hitherto been available.

Progress has been made towards the amelioration of unpromising soils in padi areas. In the tanks at Kuala Lumpur, good growth and yield of padi have been obtained on peat by the use of heavy dressings of nitrogen in the form of urea, and on *gelam* soil by leaching, draining and liming at the rate of four tons to the acre. It remains to be seen whether these results can be reproduced in the field.

Livestock

The demand for the Sitiawan Black strain of pig is increasing in many areas for fattening and for raising gilts to be crossed with Middle White boars.

An investigation of the possibility of phosphate deficiency in pigs' rations was started during the quarter.

Miscellaneous

Potash had a beneficial effect on coffee growing in peat soil. The production of secondary and tertiary branches of this crop under similar conditions appeared to be depressed by nitrogen.

Training Centres

Three courses were held at the Kota Bharu Rural Training Centre in Kelantan and the demand for places in future courses is very keen. The limited number of instructors prevents expansion of this extension service.

Extension Publications

The third number of *Berita Tanaman Kelantan* was published and 10,000 copies were distributed. This publication is in Jawi.

Review

TEA MANUFACTURE IN CEYLON

By E. L. Keegel. Monographs on Tea Production in Ceylon, No. 4. Tea Research Institute of Ceylon, St. Coombs, Talawakelle. Pp. 103 including Appendices, Bibliography and Index. Price eight shillings sterling.

This book on tea manufacture is a compilation of the findings of the Tea Research Institute of Ceylon. The constituents of green tea leaf and the chemical changes the leaf undergoes in the process of manufacture of black tea are explained in simple scientific terms.

The author describes the improved techniques developed and offers practical suggestions based on experimental and advisory work carried out on the manufacture of tea during the past 24 years by the Tea Research Institute of Ceylon.

The book is illustrated with drawings of the different types of improved roller tables and patterns and the author explains the effect of these on the efficient breaking down of the leaf during rolling. A number of analytical and other tables are also included.

For anyone interested in adopting improved scientific methods of manufacturing black tea this publication is strongly recommended as an authoritative work. A copy should be available in every tea factory.

N.K.

Obituary

It is with the deepest regret that we record the untimely death, at the age of 36, of Mr. John Chattaway, Agricultural Officer, [illegible]. [illegible] joined the Department of [illegible]. After a very short period of distinguished war service in the Royal Air Force and of university education. In coming to Malaya he continued and enhanced a family tradition of service to the people and Government of this country.

He held a number of appointments in the Field, Agronomy and Education Branches of the Department during his service here. His approach to his profession was original, stimulating and deeply thoughtful, and he had a quiet tenacity of purpose which often rightly won recognition for views which were regarded as highly unorthodox by the more conservative of us. He was an extraordinary hard worker and he made substantial contributions to the cause of Agriculture in Malaya; worthy of special mention among these were his planning and organisation of the important [illegible] now taking place in the Education Branch of the Department, and the novel and courageous manner in which he undertook his duties whilst serving in Central Johore in the early years of the Emergency.

His readiness to help others, with no regard to his own [illegible] comfort, his [illegible] and his [illegible] will be sorely missed by all of us.

To his widow and three children we extend our deepest sympathy and most sincere condolences.

Promotion

Encho Mohamed Tamin bin Yeop, Agricultural Assistant, was promoted to Pupil Agricultural Officer with effect from the 19th November, 1956. After being stationed at Headquarters, Che Mohd Tamin was transferred to the post of Agricultural Officer, Johore Central, Kluang, on the 11th March, 1957.

Transfers

Mr. K. Kanapathy, Chemist, was transferred to the post of Chemist (Soils) with effect from the 4th February, 1957.

Encho Basir bin Ismail, Pupil Agricultural Officer, was transferred from the College of Agriculture, Malaya, to the post of Agricultural Officer, Perak Central, Kuala Kangsar, with effect from the 26th February, 1957.

Mr. G. F. Darnell, Agricultural Officer, Johore Central, was transferred to the post of State Agricultural Officer, Negri Sembilan, with effect from the 18th March, 1957.

Leave

Mr. W. P. Panton, Geologist (Soil Survey), returned from leave on the 7th January, 1957.

The following officers have proceeded on leave:-

Mr. J. Chattaway, Agricultural Officer, on the 18th January, 1957.

Mr. G. W. Arnott, Chemist (Soils), on the 19th February, 1957.

Mr. L. A. Vivian, Agricultural Officer, on the 27th February, 1957.

Retirement

Mr. D. S. Boyce, Agricultural Engineer, retired under the Pensions (Entitled Officers) Ordinance with effect from the 11th November, 1956.

MARKET PRICES

October to December, 1956

Rubber.—Although the average of the noon prices paid for R.S.S. No. 1 (f.o.b. in bales, buyer) in Singapore during October was less than one cent above that for the previous month, the troubled state of affairs in the Middle East forced the price of rubber to 102.25 cents per lb. on the 31st October. Early in the month the price was at 91 cents and stood at only 92.375 cents on the 24th; thereafter there were increaseases of from one to four cents per lb. The average price for October was 93.089 cents.

On the first day's business in November the price was 102.75 cents but was afterwards forced below the $1 mark for four days. From then on the price was above $1 per lb. and, although there were fluctuations, there was a general upward movement until 115½ cents per lb. was reached on the 29th. The month ended with the price at 113 cents, to give an average for November of 104.261 cents.

The market was closed on the first two days of December but on the 3rd and 4th the price stood at 117½ and 117¾ cents respectively. Such prices could not be maintained, and on the 13th the buyers price was 107½. There was an increase of 2¼ cents on the next day. When the market opened after the Christmas holidays the price was 114.625 cents, but it was back to 112 cents on the 31st. The average price for December was 112.388 cents per lb.

The prices quoted above are those reported by the Singapore Chamber of Commerce and they have been taken from the Monthly Statistical Bulletin of the Federation of Malaya.

The average prices paid for smallholders' rubber at three towns in the Federation of Malaya are given in Table I.

Table I

Average Monthly Prices Paid by Local Dealers for Smallholders' Rubber, October to December, 1956

(dollars per pikul of 133⅓lb.)

Grades	Taiping, Perak			Seremban, Negri Sembilan			Batu Pahat, Johore		
	Oct.	Nov.	Dec.	Oct.	Nov.	Dec.	Oct.	Nov.	Dec.
Smoked Sheet No. 1	104.65	115.20	121.26	104.94	116.17	121.57	—	—	—
Unsmoked Sheet ..	87.58	96.86	100.25	85.52	92.40	96.90	90.00	98.86	100.13
Scrap	43.07	49.13	47.59	51.44	55.35	58.18	30.76	34.19	34.73

This Table has been compiled from statistics supplied by the Chief Statistician, Federation of Malaya.

Palm Oil.—The average prices paid in London during the quarter for oil shipped by the Malayan Oil Palm Pool were, per ton:- October £91.82; November £89.75; and December £90.25.

Exports of palm oil from the Federation of Malaya during the quarter totalled 17,200 tons.

Tea.—The Chief Statistician, Federation of Malaya, reports that 1,239,000 lb. of black and green teas were produced during the quarter.

The average prices paid for Ceylon teas at the sale held in Colombo on the 31st December, 1956, and as reported in the Weekly Tea Market Report of the Colombo Brokers' Association, were, in rupees per lb.:- High Grown Teas (4,000 ft. and above) 2.69; Medium Grown Teas (2,000 to 3,999 ft.) 2.31 and Low Grown Teas (below 2,000 ft.) 2.23.

Derris.—The average price of derris during the first three weeks of October was $125 per pikul. The price increased to $135 in the last week of October and stayed steady until the last two weeks of the year, when it stood at $130 per pikul.

Table II

Singapore Prices of Various Agricultural Products

(dollars per pikul)

Date	Copra, Sundried	Coconut oil*	Pepper, F.A.Q. Muntok white	Pepper, Gen. Muntok white	Gambier, Cube	Sago Flour, Lingga	Tapioca Flour No. 1	Oilcake, Round
1956								
1st Oct.	26.00	43.50	118.00	128.00	60.00	12.50	17.50	15.00
8th Oct.	26.25	43.50	116.50	126.50	60.00	12.50	17.00	15.00
15th Oct.	26.00	40.25	105.00	115.00	60.00	12.375	17.50	14.75
22nd Oct.	25.75	43.50	107.00	117.00	60.00	12.375	17.25	14.50
30th Oct.	26.50	43.50	112.00	122.00	60.00	12.25	17.00	14.50
5th Nov.	26.25	45.00	117.00	127.00	60.00	12.25	17.00	14.50
12th Nov.	26.25	43.75	119.00	129.00	60.00	12.25	17.00	15.00
19th Nov.	27.00	45.50	119.00	129.00	60.00	12.25	17.00	15.00
26th Nov.	28.75	48.00	121.00	131.00	60.00	12.25	17.00	15.50
3rd Dec.	29.25	48.50	128.00	138.00	62.00	12.50	17.00	15.50
10th Dec.	28.25	47.50	125.50	135.50	64.00	12.50	17.00	15.00
17th Dec.	28.00	46.50	122.00	132.00	64.00	12.50	17.00	15.00
24th Dec.	28.00	46.00	122.00	132.00	68.00	12.50	17.50	15.00
31st Dec.	28.25	46.50	127.00	137.00	65.00	12.50	17.50	15.00

* F.O.B. in second-hand drums.

The above prices are taken from the weekly reports of the Singapore Chamber of Commerce.

FEDERATION OF MALAYA

PRODUCTION OF PALM OIL AND KERNELS

(in long tons as declared by estates)

Month	Palm Oil		Palm Kernels	
	1955	1956	1955	1956
January ..	4,093	3,712	1,124	1,038
February ..	3,997	3,697	1,081	1,013
March ..	4,854	4,520	1,300	1,229
April ..	4,630	4,105	1,221	1,079
May ..	4,152	4,364	1,076	1,096
June ..	5,135	5,263	1,256	1,310
July ..	4,802	4,977	1,238	1,210
August ..	5,128	5,303	1,348	1,383
September ..	5,073	5,098	1,269	1,285
October ..	4,855	5,387	1,262	1,411
November ..	4,952	4,842	1,348	1,233
December ..	4,820	4,654	1,366	1,208
Total ..	56,491	55,922	14,889	14,495

MALAYAN AGRICULTURAL EXPORTS
JULY TO SEPTEMBER, 1956

Product	Net Exports in Tons			
	Year 1954	Year 1955	July-Sept., 1955	July-Sept., 1956
Arecanuts ..	5,511	13,679	300	721
Coconuts, fresh †† ..	94,433 †	72,140 †	14,131 †	16,615 †
Coconut oil ‡ ..	78,507	91,176	24,767	29,049
Copra ‡ ..	67,472 *	75,076 *	24,064 *	18,099 *
Copra cake ..	40,520 *	56,404 *	17,501 *	16,469 *
Gambier, all kinds ..	134 *	66	8 *	—
Palm Oil ..	48,908	52,832	14,508	10,843
Pineapples, canned ..	21,533	27,756	8,401	9,466
Rubber ¶ ..	585,081 §	637,463	166,144	159,541
Sago, flour ..	27,980	23,053	4,815	6,219
Sago, pearl ..	5,122	5,483	1,488	974
Sago, raw ..	27,021 *	18,709 *	5,749 *	3,965 *
Tapioca, flake ..	49	475	104	43
Tapioca, flour ..	4,555 *	3,979 *	1,183 *	850 *
Tapioca, pearl ..	7,865	5,470	1,093	1,534
Derris ..	16	13	1	—
‡ Copra equivalent ..	88,943	74,528	15,900	29,437

¶ production (Federation of Malaya). † hundreds in number. * net imports.
§ This figure includes an adjustment of +2,090 tons shown in annual returns.

FEDERATION OF MALAYA RUBBER PRODUCTION

(in long tons, dry weight)

Month	Estates		Smallholdings (Estimated)		Total	
	1955	1956	1955	1956	1955	1956
January ..	29,260	32,515	26,033	26,428	55,293	58,943
February ..	28,497	27,503	21,928	23,848	50,425	51,351
March ..	27,465	28,408	24,874	22,433	52,339	50,841
April ..	24,155	26,591	20,415	21,647	44,570	48,238
May ..	27,355	23,389	22,331	19,703	49,686	43,092
June ..	27,497	29,409	22,841	23,109	50,338	52,518
July ..	30,238	30,709	25,647	23,807	55,885	54,516
August ..	30,650	30,201	23,571	22,927	54,221	53,128
September ..	31,274	30,123	24,764	21,774	56,038	51,897
October ..	30,724	30,386	23,960	22,455	54,684	52,841
November ..	30,174	28,363	21,743	21,179	51,917	49,542
December ..	34,893	34,636	27,174	24,058	62,067	58,694
Total ..	351,802*	352,233	285,281	273,368	637,083*	625,601
Total 1954 ..	344,851		240,230		585,081	

This Table has been compiled from statistics published by the Chief Statistician, Federation of Malaya.

Production on smallholdings (estates of less than 100 acres) is taken as the total of purchases from smallholders reported by licensed dealers.

* These are amended figures for the year and have been taken from figures submitted by estates in their Annual Questionnaires.

FEDERATION OF MALAYA

PRODUCTION OF COPRA, COCONUT OIL AND COPRA CAKE

(in tons)

Month	Copra Production						Coconut Oil Production		Copra Cake (Poonac) Manufactured	
	Estates (a)		Smallholdings (estimated)		Total		Oil Mills		Oil Mills	
	1955	1956	1955	1956	1955	1956	1955	1956	1955	1956
January ..	2,674	2,728	4,297	7,808	6,971	10,536	5,523	8,247	3,561	5,197
February ..	2,797	2,713	8,366	8,457	11,163	11,170	7,753	7,369	4,508	4,612
March ..	2,975	3,032	7,726	6,463	10,701	9,495	7,368	8,459	4,603	5,232
April ..	3,021	2,878	7,478	7,188	10,499	10,066	6,165	7,916	3,934	4,855
May ..	3,619	2,813	7,630	11,015	11,249	13,828	7,399	8,729	4,580	5,434
June ..	3,748	3,133	10,534	9,457	14,282	12,590	8,017	9,193	5,128	5,731
July ..	3,955	3,360	12,311	10,971	16,266	14,831	8,538	9,410	5,400	5,849
August ..	4,188	4,140	10,275	14,003	14,463	18,140	8,580	11,447	5,370	7,132
September ..	3,745	3,986	9,511	12,896	13,256	16,882	9,259	9,567	5,749	6,028
October ..	3,591	3,807	9,730	10,605	13,321	14,412	9,240	9,403	5,787	6,363
November ..	2,850	2,992	8,436	8,291	11,286	11,283	9,059	9,195	5,758	5,739
December ..	3,301	2,927	7,180	7,894	10,481	10,821	8,050	9,438	5,062	5,726
Total ..	40,464	39,009	103,524	115,015	143,988	154,054	94,956	108,373	59,740	67,808

Notes:—1. The above Table has been compiled from statistics published by the Chief Statistician, Federation of Malaya.

2. Estate copra production and coconut oil production are as declared by estates and oil mills respectively.

3. Statistics of smallholding coconut oil production are not available.

4. Smallholding copra production for commercial purposes is estimated from the formula: imports + estate stocks (opening) + estate production + smallholding production = exports + local oil mill consumption + estate stocks (closing).

(a) Includes copra equivalent of sales of fresh nuts by estates.

METEOROLOGICAL SUMMARY, MALAYA, OCTOBER, 1956

Locality	Air Temperature Degrees Fahrenheit							Earth Temperature		Rainfall									Bright Sunshine		
	Means of			Absolute Extremes				At 1 foot	At 4 feet	Total		Most in a day	Number of Days						Total	Daily Mean	Per cent.
	A. Max.	B. Min.	Means of A and B	Highest Max.	Lowest Min.	Lowest Max.	Highest Min.	° F.	° F.			Amt.	Precipitation .01 in. or more	Precipitation .04 in. or more	Thunderstorm	Fog morning obs.	Gale force 8 or more				
										in.	mm.	in.							hr.	hr.	
Ipoh, Perak ..	90.3	72.8	81.5	93.2	70.2	82.2	75.7			14.93	379.2	2.90	25	21	9				165.40	5.33	
Kuala Lumpur, Selangor	88.8	72.7	80.7	91.9	70.2	83.4	75.9			12.60	320.0	4.02	22	18	7	4			175.35	5.66	
Sitiawan, Perak ..	88.1	72.7	80.4	91.3	70.2	80.7	75.6	84.1	85.1	7.56	192.0	1.90	19	13	1				167.15	5.39	
Kuantan, Pahang ..	87.5	71.9	79.7	90.8	70.4	81.3	74.4	82.5		12.24	310.9	1.69	19	18	9	15			137.25	4.43	
Bayan Lepas, Penang ..	85.7	73.4	79.5	88.4	70.2	81.5	76.1			19.26	489.2	3.35	24	22	6				163.60	5.28	
Malacca ..	87.0	73.2	79.5	89.8	70.8	83.0	74.7			6.53	165.9	2.36	17	16	1				170.40	5.50	
Mersing, Johore ..	86.6	71.2	78.9	92.1	68.2	80.6	73.1			11.45	290.8	1.82	23	20	3				163.05	5.26	
Alor Star, Kedah ..	86.9	73.1	80.0	90.4	71.8	78.2	75.4			12.82	325.6	1.62	27	19	6	4			161.45	5.21	
Kota Bharu, Kelantan ..	85.3	73.7	79.5	88.8	72.0	79.7	75.5	83.5	85.5	15.60	396.2	3.80	25	21	6	2			181.50	5.85	
K. Trengganu, Trengganu	85.5	73.0	79.3	88.0	71.1	79.7	76.1			7.21	183.1	1.90	20	14					176.10	5.68	
Singapore ..	86.4	73.9	80.1	89.5	71.5	81.0	77.2			8.12	206.2	2.58	18	17	4				130.05	4.19	
HILL STATION																					
Cameron Highlands, Tanah Rata, Pahang. (4750 ft.)	73.8	55.7	64.7	77.0	49.2	70.4	61.0			15.13	384.3	3.07	27	26					114.65	3.70	

Compiled from returns supplied by the Malayan Meteorological Service.

FEDERATION OF MALAYA

PRODUCTION OF COPRA, COCONUT OIL AND COPRA CAKE

(in tons)

Month	Copra Production						Coconut Oil Production		Copra Cake (Poonac) Manufactured	
	Estates (a)		Smallholdings (estimated)		Total		Oil Mills		Oil Mills	
	1955	1956	1955	1956	1955	1956	1955	1956	1955	1956
January ..	2,674	2,728	4,297	7,808	6,971	10,536	5,528	8,247	3,561	5,197
February ..	2,797	2,713	8,366	8,457	11,163	11,170	7,753	7,369	4,808	4,612
March ..	2,975	3,032	7,726	6,463	10,701	9,495	7,368	8,459	4,603	5,242
April ..	3,021	2,878	7,478	7,188	10,499	10,066	6,165	7,916	3,934	4,855
May ..	3,619	2,813	7,630	11,015	11,249	13,828	7,399	8,729	4,580	5,434
June ..	3,748	3,133	10,534	9,457	14,282	12,590	8,017	9,193	5,128	5,731
July ..	3,955	3,860	12,311	10,971	16,266	14,831	8,538	9,410	5,400	5,849
August ..	4,188	4,140	10,275	14,000	14,463	18,140	8,580	11,447	5,370	7,132
September ..	3,745	3,986	9,511	12,896	13,256	16,882	9,259	9,567	5,749	6,028
October ..	3,591	3,807	9,730	10,605	13,321	14,412	9,240	9,403	5,787	6,263
November ..	2,850	2,992	8,486	8,291	11,336	11,283	9,059	9,195	5,758	5,739
December ..	3,301	2,927	7,180	7,894	10,481	10,821	8,050	9,438	5,062	5,726
Total ..	40,464	39,009	103,524	115,045	143,988	154,054	94,956	108,373	59,740	67,808

Notes:—1. The above Table has been compiled from statistics published by the Chief Statistician, Federation of Malaya.

2. Estate copra production and coconut oil production are as declared by estates and oil mills respectively.

3. Statistics of smallholding coconut oil production are not available.

4. Smallholding copra production for commercial purposes is estimated from the formula: imports + estate stocks (opening) + estate production + smallholding production = exports + local oil mill consumption + estate stocks (closing).

(a) Includes copra equivalent of sales of fresh nuts by estates.

METEOROLOGICAL SUMMARY, MALAYA, OCTOBER, 1956

Locality	Air Temperature Degrees Fahrenheit							Earth Temperature		Rainfall								Bright Sunshine		
	Means of			Absolute Extremes				At 1	At 4	Total		Most in a day	Number of Days					Total	Daily Mean	Per cent.
	A. Max.	B. Min.	Means of A and B	Highest Max.	Lowest Min.	Lowest Max.	Highest Min.	foot ° F.	feet ° F.			Amt.	Precipitation .01 in. or more	Precipitation .04 in. or more	Thunderstorm	Fog morning obs.	Gale force 8 or more			
										in.	mm.	in.						hr.	hr.	
Ipoh, Perak ..	90.3	72.8	81.5	93.2	70.2	82.2	75.7			14.93	379.2	2.90	25	21	9			165.40	5.33	
Kuala Lumpur, Selangor	88.8	72.7	80.7	91.9	70.2	83.4	75.9			12.60	320.0	4.02	22	18	7	4		175.35	5.66	
Sitiawan, Perak ..	88.1	72.7	80.4	91.3	70.2	80.7	75.6	84.1	85.1	7.56	192.0	1.90	19	13	1			167.15	5.39	
Kuantan, Pahang ..	87.5	71.9	79.7	90.8	70.4	81.3	74.4	82.5		12.24	310.9	1.69	19	18	9	15		137.25	4.43	
Bayan Lepas, Penang ..	85.7	73.4	79.5	88.4	70.2	81.5	76.1			19.26	489.2	3.35	24	22	6			163.60	5.28	
Malacca ..	87.0	73.2	79.5	89.8	70.8	83.0	74.7			6.53	165.9	2.36	17	16	1			170.40	5.50	
Mersing, Johore ..	86.6	71.2	78.9	92.1	68.2	80.6	73.1			11.45	290.8	1.82	23	20	3			163.05	5.26	
Alor Star, Kedah ..	86.9	73.1	80.0	90.4	71.8	78.2	75.4			12.82	325.6	1.62	27	19	6	4		161.45	5.21	
Kota Bharu, Kelantan ..	85.3	73.7	79.5	88.8	72.0	79.7	75.5	83.5	85.5	15.60	396.2	3.80	25	21	6	2		181.50	5.85	
K. Trengganu, Trengganu	85.5	73.0	79.3	88.0	71.1	79.7	76.1			7.21	183.1	1.90	20	14				176.10	5.68	
Singapore ..	86.4	73.9	80.1	89.5	71.5	81.0	77.2			8.12	206.2	2.58	18	17	4			130.05	4.19	
HILL STATION																				
Cameron Highlands, Tanah Rata, Pahang. (4750 ft.)	73.8	55.7	64.7	77.0	49.2	70.4	61.0			15.13	384.3	3.07	27	26				114.65	3.70	

Compiled from returns supplied by the Malayan Meteorological Service.

METEOROLOGICAL SUMMARY, MALAYA, NOVEMBER, 1956

Locality	Air Temperature Degrees Fahrenheit							Earth Temperature		Rainfall							Bright Sunshine		
	Means of			Absolute Extremes				At 1 foot	At 4 feet	Total		Most in a day	Number of Days				Total	Daily Mean	Per cent.
	A. Max.	B. Min.	Means of A and B	Highest Max.	Lowest Min.	Lowest Max.	Highest Min.	° F.	° F.			Amt.	Precipitation .01 in. or more	Precipitation .04 in. or more	Thunderstorm	Fog morning obs.	Gale force 8 or more			
										in.	mm.	in.						hr.	hr.	
Ipoh, Perak ..	90.4	72.4	81.4	93.6	69.3	83.0	75.3			13.90	353.1	3.16	21	17	7			187.65	6.25	
Kuala Lumpur, Selangor	88.2	73.4	80.8	91.7	71.9	78.1	76.0			8.56	217.4	1.46	21	17	6	5		151.20	5.04	
Sitiawan, Perak ..	87.7	72.1	79.9	91.0	69.0	82.2	75.8	83.1	84.5	12.95	328.9	1.98	20	19	9	5		188.15	6.27	
Kuantan, Pahang ..	85.2	72.2	78.7	90.7	69.7	77.8	75.1	81.0		20.68	525.3	4.40	24	22	3	4		105.65	3.52	
Bayan Lepas, Penang ..	86.9	74.1	80.5	91.6	69.8	81.8	77.4			5.23	132.8	1.13	17	15	4			196.55	6.55	
Malacca ..	85.9	73.2	79.5	90.1	71.0	77.4	75.0			11.18	284.0	3.20	23	21	1			131.70	4.39	
Mersing, Johore ..	84.2	71.8	78.0	89.8	68.8	78.8	74.3			19.08	484.6	4.44	26	24				114.00	3.80	
Alor Star, Kedah ..	87.5	72.4	79.9	91.4	65.7	81.4	74.6			6.30	160.0	1.26	14	11	2	3		193.30	6.44	
Kota Bharu, Kelantan ..	84.4	73.9	79.1	88.8	70.3	79.9	79.0	80.2	81.8	18.63	473.2	6.17	23	22	6	1		148.25	4.94	
K. Trengganu, Trengganu	84.0	73.4	78.7	89.3	71.8	78.7	76.4			13.04	331.2	2.65	23	19				135.20	4.51	
Singapore ..	84.4	73.9	79.1	89.3	71.8	76.2	75.5			16.30	414.0	3.04	21	18	8			83.55	2.79	
HILL STATION																				
Cameron Highlands, Tanah Rata, Pahang. (4750 ft.)	71.9	55.8	63.9	75.0	49.0	65.5	61.8			12.07	306.6	1.50	25	23				116.30	3.88	

Compiled from returns supplied by the Malayan Meteorological Service.

METEOROLOGICAL SUMMARY, MALAYA, DECEMBER, 1956

Locality	Air Temperature Degrees Fahrenheit							Earth Temperature		Rainfall							Bright Sunshine		
	Means of			Absolute Extremes				At 1 foot	At 4 feet				Number of Days						
	A. Max.	B. Min.	Means of A and B	Highest Max.	Lowest Min.	Lowest Max.	Highest Min.	° F.	° F.	Total	Most in a day Amt.		Precipitation .01 in. or more	Precipitation .04 in. or more	Thunderstorm	Fog morning obs.	Gale force 8 or more	Total	Mean Daily	Per cent.
										in.	mm.	in.						hr.	hr.	
Ipoh, Perak ..	89.4	71.8	80.6	93.3	69.6	81.9	73.6			12.80	325.1	2.16	17	15	3	1		155.65	5.02	
Kuala Lumpur, Selangor	87.7	72.3	80.0	91.0	68.9	81.5	74.5			10.20	259.1	1.97	22		6	5		146.35	4.72	
Sitiawan, Perak ..	86.9	72.0	79.5	90.3	69.5	79.5	73.7	87.2	84.1	5.93	150.6	1.37	18	14	2	3		155.80	5.03	
Kuantan, Pahang ..	83.1	71.0	77.1	88.5	66.8	78.3	73.8	79.0		12.25	311.2	2.80	24	23	2			86.90	2.80	
Bayan Lepas, Penang ..	87.0	73.3	80.1	90.2	70.6	81.5	76.2			2.56	65.0	1.20	12	5	2			193.80	6.25	
Malacca ..	86.1	72.8	79.5	89.1	70.6	82.9	74.1			6.28	159.5	1.11	19	16				137.00	4.42	
Mersing, Johore ..	82.1	72.3	77.2	90.1	68.6	77.4	75.4			15.32	389.1	6.07	22	20	1			107.95	3.48	
Alor Star, Kedah ..	87.0	70.6	78.8	90.2	67.0	79.1	73.1			3.54	89.9	0.94	11	10				189.30	6.11	
Kota Bharu, Kelantan ..	81.2	72.3	76.7	85.2	69.2	74.5	76.8	77.1	78.0	43.09	1,094.5	8.44	19	17	2	1		135.50	4.37	
K. Trengganu, Trengganu	81.1	71.8	76.5	84.4	68.0	74.8	74.9			28.91	734.3	4.24	21	19				116.55	3.76	
Singapore ..	85.2	72.8	79.0	89.5	70.0	78.0	74.6			10.00	254.0	1.80	21	19	5			146.35	4.72	
HILL STATION																				
Cameron Highlands, Tanah Rata, Pahang. (4750 ft.)	70.9	56.4	63.7	74.0	49.0	67.2	60.8			13.84	351.5	1.98	24	22				95.35	3.07	

Compiled from returns supplied by the Malayan Meteorological Service.

METEOROLOGICAL SUMMARY, MALAYA, JANUARY, 1957

Locality	Air Temperature Degrees Fahrenheit							Earth Temperature		Rainfall								Bright Sunshine		
	Means of			Absolute Extremes				At 1	At 4				Number of Days							
	A. Max.	B. Min.	Means of A and B	Highest Max.	Lowest Min.	Lowest Max.	Highest Min.	foot	feet	Total		Most in a day	Precipitation .01 in. or more	Precipitation .04 in. or more	Thunderstorm	Fog morning obs.	Gale force 8 or more	Total	Daily Mean	Per cent.
								° F.	° F.	in.	mm.	in.						hr.	hr.	
Ipoh, Perak ..	91.9	70.6	81.3	94.8	66.1	84.1	74.2			3.13	79.5	1.04	11	10	3			232.80	7.51	
Kuala Lumpur, Selangor	89.8	71.2	80.5	93.8	66.8	83.4	74.5			4.47	113.5	2.63	10	8	4	3		224.15	7.23	
Sitiawan, Perak ..	88.4	70.5	79.5	91.3	64.1	84.9	73.2	83.6	84.5	2.48	63.0	0.94	7	6	2	1		240.75	7.77	
Kuantan, Pahang ..	84.9	69.6	77.3	88.8	62.8	79.9	74.0	79.0		1.41	35.8	0.41	12	9		1		167.90	5.42	
Bayan Lepas, Penang ..	88.6	72.4	80.5	91.8	66.2	84.2	75.9			0.91	23.1	0.73	5	2				255.90	8.25	
Malacca ..	89.7	72.6	81.1	94.0	68.0	83.0	75.7			3.95	100.3	2.76	3	3				220.60	7.88	
Mersing, Johore ..	82.1	73.5	77.8	85.0	67.4	79.0	76.3			1.83	46.5	0.84	11	7				176.85	5.70	
Alor Star, Kedah ..	89.4	69.3	79.3	95.3	63.4	80.0	73.8			1.39	35.3	0.56	5	5	1			255.60	8.25	
Kota Bharu, Kelantan ..	83.1	72.2	77.7	85.0	67.2	80.0	77.9	81.0	81.5	2.76	70.1	0.89	12	9		2		184.20	5.94	
K. Trengganu, Trengganu	82.0	72.1	77.1	84.2	68.7	77.9	76.0			1.40	35.6	0.41	10	7		1		156.15	5.04	
Singapore ..	86.4	73.1	79.7	90.1	70.6	82.2	75.0			4.20	106.7	2.20	12	8	2			171.20	5.52	
HILL STATION																				
Cameron Highlands, Tanah Rata, Pahang. (4750 ft.)	70.9	51.9	61.4	74.8	42.0	61.4	59.0			1.91	48.5	0.87	9	8				174.30	5.62	

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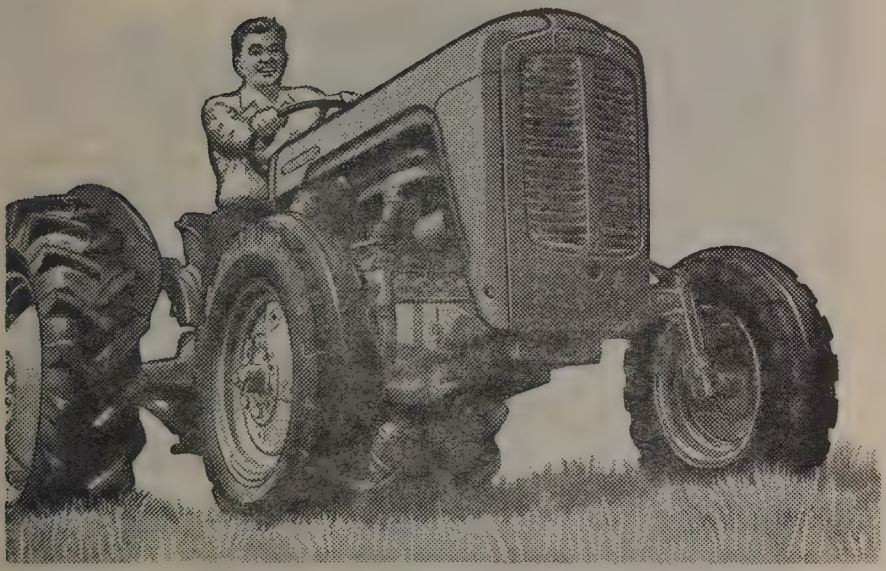

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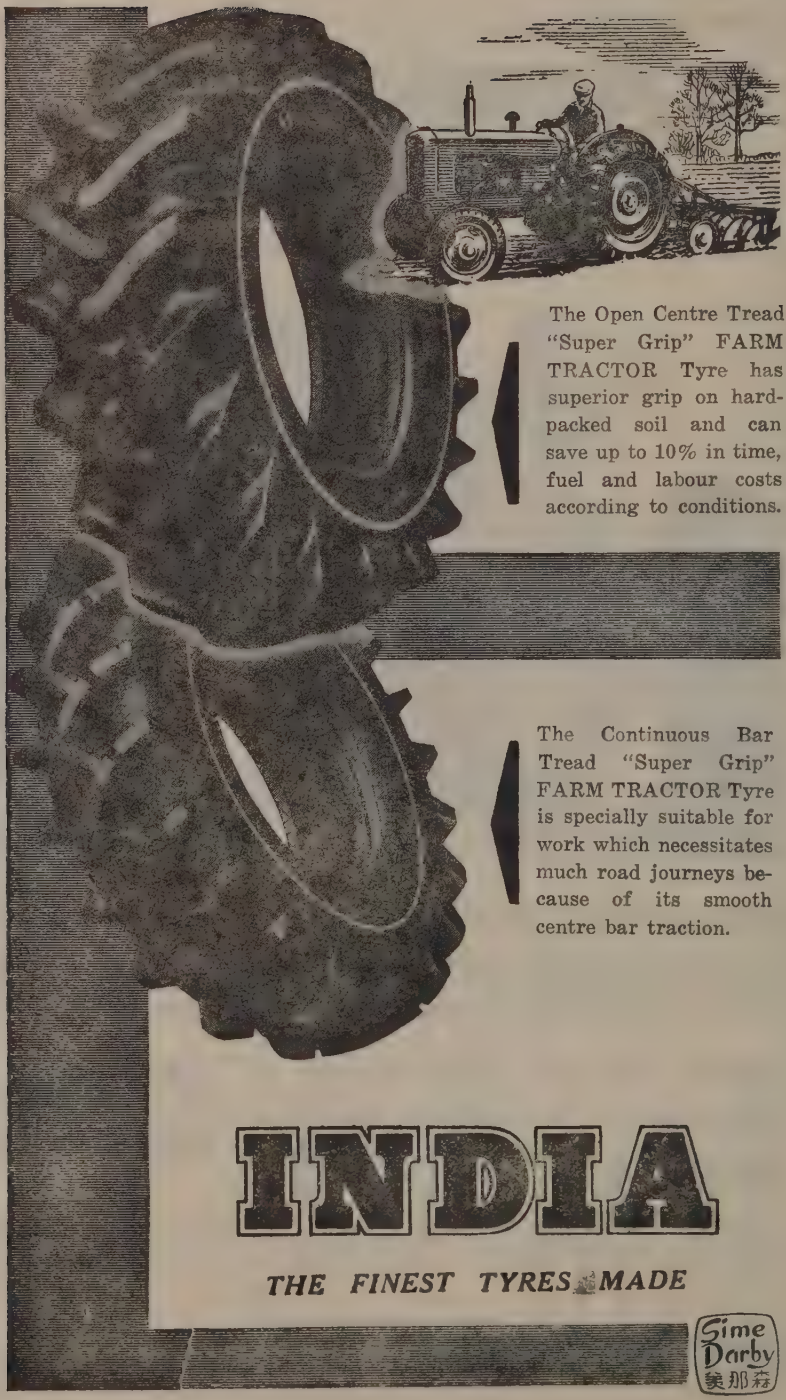
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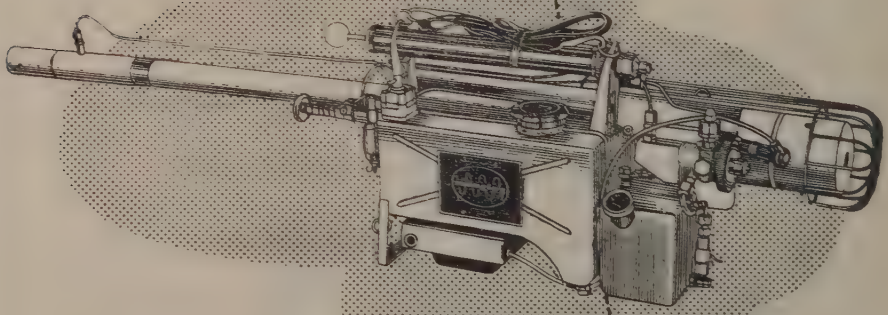

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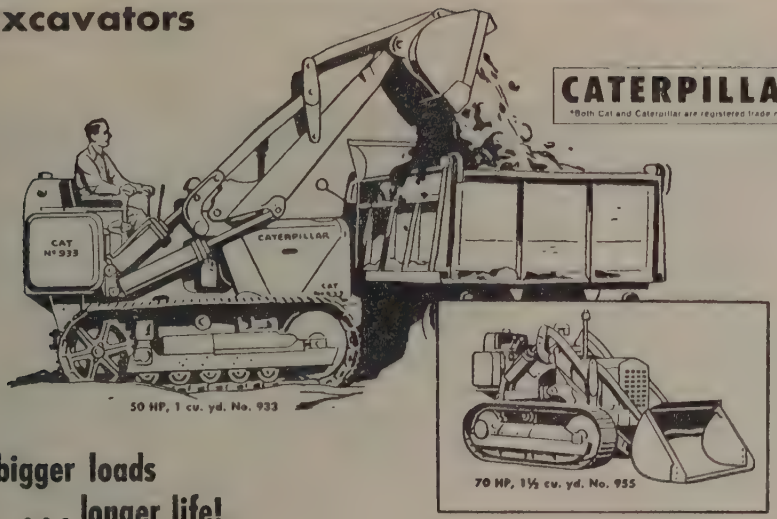

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